TOLT RIVER WATERSHED ANALYSIS

SURFACE EROSION ASSESSMENT MODULE

—ROADS—

The following report summarizes the results of the road surface erosion assessment module conducted for the Tolt River watershed. All products, including forms and maps, have been reviewed by the Tolt Watershed Analysis participants and their comments have been incorporated.

Mary Raines

Mary Raines, Certified Module Leader

4-12-93

Date

Prepared for Weyerhaeuser Company

In accordance with
Standard Methodology for Conducting Watershed Analysis
Chapter 222-22 WAC, Version 1.P
10

Washington Forest Practices Act Board Manual

TOLT WATERSHED ANALYSIS

(B) SURFACE EROSION: ROADS

Analyst/Specialist: Mary Raines, Cascades Environmental Services, Inc.

GENERAL ROAD/BASIN INFORMATION

The potential for surface erosion from forest roads varies considerably and is dependent on location or layout, construction practices, drainage, and use. Soil particles on road surfaces, ditches, cutbanks, and fills are entrained by raindrop impact and the shear stress imparted by water flowing in sheets and rills. Erosion from road surfaces is extremely sensitive to traffic levels which produces sediment by the pumping of fines from the substrate through the surfacing and breakdown of surfacing materials. Heavily trafficked logging roads have been shown to produce substantially more sediment than abandoned or low-use roads. Road sediment is mobilized during most rainfall events and snowmelt and can be considered a chronic as opposed to an episodic fine sediment source, such as mass wasting, streambank erosion, or remobilization of channel-stored sediments. Road sediment produced from lightly trafficked roads will decrease during the rainfall season as available fines are winnowed from the tread and ditches. Sediment introduced into stream channels from road surface erosion is assumed to be 2 mm or finer (Duncan et al., 1987; Reid, personal communication, 1989).

Road density in the Tolt is considered to be of significant quantity for field analysis according to the Level 1 screen (greater than 1 mi/mi^2). The basin-wide road density is approximately 3 mi/mi^2 but varies within sub-basins (see road density graph and Road Density/Sediment Summary).

Surface erosion potential from Tolt River watershed roads is in general dependent on two main variables: 1) the percent of road runoff/sediment directly deliverable to streams, and 2) the type and amount of traffic. Deliverability is influenced by the location of the roads in either the westerly lowland area or the easterly highland area. The topography unique to each area dictates similar road construction and drainage patterns. For the purposes of this analysis, the watershed has been divided by lowland and highland areas and by sub-basins within these areas.

Roads in the lowland areas are generally lower gradient with fewer stream crossings due to lower topographic relief and a lower stream density in the glacial deposits underlaying most of this area. Lowland roads also parallel a number of wetlands and low gradient stream reaches. Roads here are older than highland roads, and cutbanks and fillslopes are generally well vegetated. Where ditches had not been recently cleaned, most were grass-lined indicating that ditch erosion is not active. The majority of high-use mainline roads are in the lower portion of the basin.

Highland area roads are younger than the lowland roads, are built on steeper slopes, and hence have larger and more frequent cutbanks and fillslopes with less vegetation. The drainage density in the highlands is greater and consequently road drainage delivery to streams will be greater as well. Surfacing varies by availability and is absent on some roads and consists of crushed ballast on others. These are mainly CAT built roads with lots of side cast. A high frequency of fill slope failures has initiated road maintenance measures. Management has been periodically pulling back fill on roads with tension cracks and replacing culverts. Most roads are heavily waterbarred annually, a practice began three years ago. Some sections of road have been put-to-bed with full side-cast pull back.

ANALYSIS METHOD

Road erosion details presented in this report contain a mix of detailed, site-specific information for those road segments field sampled and generalized information on portions of the road system considered particularly problematic. Areas of concern for fine sediments were targeted for field surveys. In addition, all mainline roads north of the South Fork and west of Dry Creek and segments in the light truck, light general use, and non-use categories were field surveyed for estimates of sediment contributions. The distribution of surveyed roads by area and road class are tabulated in the Road Survey Summary.

Snow proved to be a limiting factor to surface erosion analysis at this time of year. Winter blow-down limited road access in the northern portion of the watershed. A helicopter flight of the entire basin provided additional perspective.

Field personnel included Mary Raines, Weyerhaeuser consultant, Nancy Sturhan, DNR soils scientist, and Julie Montalvo, a Weyerhaeuser sub-contractor under the direction of M. Raines. Active observers/advisors to the process included Michael Bonoff and Sandra Donnelly with the Seattle Water Department, Garrett Jackson, consultant for the Seattle Water Department, Sue Perkins and Lori Druffel with King County Surface Water Management, and Kate Sullivan, Weyerhaeuser hydrologist.

Field surveys were similar to Level 1 methods except that every runoff/sediment entry point on a surveyed road segment was evaluated individually for sediment contribution. A different field form was used to aid in recording delivery potential. Road segments field checked are indicated on a paper map of the road system. Roads where detailed surveys were conducted are traced in red pencil and labeled with site numbers corresponding to field notes. Roads traced in blue are those where no sediment contributing road problems were observed or a more cursory, Level 1 survey was conducted.

Field forms and road erosion calculation worksheets are included with this report. Erosion worksheets from the detailed surveys include a calculation of estimated road sediment delivered to streams from each crossing in tons per year, in addition to an average rate of sediment in tons/road prism acre/year for that road segment. The sediment yield numbers can be used to flag those crossings or areas generating the most sediment, and the rates were used to extrapolate sediment yield estimates to similar roads in the basin not surveyed. The basic erosion rates and corrections made for local conditions from the Level 1 method were used in estimating all sediment yields and rates.

The majority of roads in the upper North Fork and upper South Fork sub-basins were considered similar enough in construction and topography to treat as a group. Limited field surveys were conducted in relatively snow-free segments of the mainline, a low elevation spur, and 65% of the road paralleling the reservoir. The remainder of roads were evaluated for sediment potential by characterizing roads based on interviews with road managers Steve Anderson and Reid Sims from Weyerhaeuser and the Seattle Water Department respectively.

Following the field work and interviews with management, road classes representative of basin roads were selected, and erosion rates were assigned from either averaging rates from similar segments from the field surveys or generating rates based on general road conditions estimated from interviews with managers, the helicopter flight survey, and aerial photographs. The assigned rates were then used to estimate total annual sediment yield from Tolt roads by sub-basin and road class.

For comparison and analysis purposes, the watershed was divided into the following sub-basins based on drainage and similarity of roads:

Lower mainstem Tolt	Lowland
Stossel Creek	Lowland
Lower North Fork	Lowland
Yellow Creek	Mix of low and highland
Upper North Fork	Highland
South Fork below the dam	Lowland
South Fork above the dam	Highland

The detailed surveys were conducted on sample roads in the same manner as we would assume would be done for the entire road system as part of a comprehensive road management plan. Road surveys will assess sediment delivery and identify problem locations on all road segments for the purpose of prioritizing maintenance and rehabilitation work.

ANALYSIS RESULTS

All road segments, with the exception of the south reservoir road, ranked Low in overall road erosion hazard according to the manual method ranking; however, individual crossings fell in high, medium, and low rankings when calculated separately. Road surface erosion Map bb-2 reflects the overall ratings. The low overall hazard ratings for individual road segments are driven mainly by the low deliverability of roads in the lowland areas and lower traffic levels in the highland areas.

Map bb-2 also shows the location of known road hazard areas determined from the field surveys and problematic road systems or areas determined from interviews with management, the flight survey, and aerial photographs. The attached list provides a description of the fine sediment/surface erosion condition at each site or area by road erosion number (RE #). Detailed road surveys will need to be completed to identify site-specific problems on non-surveyed roads.

Estimated road sediment yield for each sub-basin by road class is summarized in the following sub-basin sediment summary tables and in the Road Density/Sediment Summary. The most significant results are summarized as follows:

1. The total estimated annual fine sediment delivered to streams in the Tolt Watershed is 9,360 tons.

2. Although the total length of basin roads is equally divided between the lowland and highland, 75% of the annual sediment yield is generated from highland roads despite the lack of mainline road in this area.

3. Road maintenance measures aimed at reducing sediment delivery to streams could have a significant impact on total sediment yield. For example, the highland road sediment estimate could be reduced by 1750 tons annually by decreasing the overall delivery rate from the estimated 33 percent to 25 percent, which means diverting 8 percent of the road drainage to non-contributing areas.

4. Roughly 50% of the basin sediment yield is generated from highland general-use roads alone, which includes the problematic Titicaca and Bobcat Creek systems in addition to 70 miles of general use road with an estimated 33% delivery rate. 31% of basin roads fall in the highland general use category.

5. The South Fork sub-basin above the dam has the highest sediment per mile rate of 62 tons. A high delivery rate from the disturbed south reservoir road contributes significantly to this number.

6. In the lowland, mainline roads contribute 21% of basin sediment from 9% of basin roads.

7. Yellow Creek has the third highest road sediment rate due to the mix of both highland and lowland topography.

8. Stossel Creek has the highest lowland road sediment rate due to a high road density and length of deliverable mainline road.

9. Lower Mainstem Tolt road sediment rate is the lowest in the basin at 2 t/road mile due to low road density, low deliverability of road sediments, and low traffic use.

10. Theoretically, the total annual basin sediment yield from roads could be reduced by 16% (1500 tons) by closing off all general use roads to traffic.

Additional analysis interpretation is provided for specific areas under the general comments below.

CONFIDENCE IN ANALYSIS

Experience from road surveys indicates that individual road crossings may locally generate a disproportionate amount of sediment, and it is expected that for most roads this would be the case. These conditions have been averaged into the survey samples and are reflected in the estimated rates used for the unsurveyed roads. Estimates of erosion rates for two highland road segments revised following subsequent physical surveys were adjusted by a factor of 4, affecting total highland sediment estimates by 37 percent. Sediment rates and adjusted estimates are within the order-of-magnitude accuracy assigned to this type of analysis and justify moderate to high confidence levels in predicting relative rates of sediment generated from road surface erosion.

Site-specific erosion problems are limited to those road segments that were field surveyed. The larger the field sample of roads and road classes within the total, the higher the confidence will be in identifying specific factors contributing to surface erosion common to entire road systems, either due to physical characteristics or road construction practices. An example of this is, as a result of limited highland surveys, we determined that highland ditches carry a lot of runoff from cutbanks and slopes where ditches in the lowland areas function mainly to drain the roads.

Confidence in identifying general road characteristics and the relative amount of sediment contributions from different road classes in the lowland portion of the basin is high. 81 percent of mainline, high-sediment-contributing roads were field checked (see Road Survey Summary). Secondary or light truck traffic use roads were also well represented in the sample. Light general and non-use lowland roads surveyed constitute 6 and 3 percent of those totals. Although the lower traffic use roads are under-represented in the sample, the general topography and road construction practices common to all lowland roads were well-sampled within the higher-use categories.

Confidence in evaluating surface erosion from highland roads is moderate for identifying general road characteristics for estimating sediment rates, and low for identifying specific causal mechanisms of erosion. General road characteristics have been adequately described, but the most significant unknown is the percentage of sediment delivery. Changes in estimated road widths, cutbanks and fill vegetation, and ditch armoring would potentially make less difference in the estimates. In the absence of field data, road sediment delivery in the upper North and South Forks was estimated at 33% for most roads, an empirically derived average from studies in similar harvested environments (Sullivan et al., 1989, Raines, 1991) and 10% for roads put-to-bed. Road maintenance measures may have reduced the 33% empirical average. Confidence in the sediment estimates would improve from moderate to high upon field sampling for delivery and general road characteristics.

Confidence in identifying causal mechanisms of highland road surface erosion will increase from low to moderate and high with adequate field sampling. With the current level of field checking and management information, suspected causal mechanisms of erosion include direct delivery rates to streams, variable surfacing, intercepted slope drainage, slope instability, unvegetated cuts and fills, traffic levels, and high road gradients. Erosion may also occur because of the lack of adequate water drainage due to ditch infilling or inadequate inboard ditches and relief culverts. Water building up on the road surface will overload the existing drainage facilities resulting in gullying and fill failures.

Sediment estimates indicate that 50% of Tolt basin road sediment is potentially generated from the 94 miles of highland general use roads, which suggests a diffused source. Only 2.3% of these roads have been surveyed. Field surveys on these roads will help focus maintenance efforts.

NEW ROAD CONSTRUCTION

Planned road construction totals approximately 7.2 miles within the next 3 years (93-95). Weyerhaeuser management has not planned new roads beyond 1995 at this time. All of these roads are short spurs off of existing road systems and lie entirely within the lowland area. The locations of planned roads are marked in red on the road surfacing and use information map provided by Weyerhaeuser. The time distribution of construction within the 3 year period is not known, but assuming all 7.2 miles are built the same year with an average 30 foot road prism width and 15% delivery rate and heavy log truck traffic during the first year, increases in sediment yield are estimated as follows:

	Traffic Use	ER Rate	ER 15% Delivery	Est. Annual Sed. Yield
Year 1	H	110	16.5	430 tons
Year 2	G	41	6.1	160 tons
Year 3+	G	29	4.4	115 tons

The increase in basin road sediment yield is estimated at approximately 4-5% during the first year of construction, decreasing to 1% by year 3. The delivery rate has been estimated conservatively based on delivery rates off the mainline in the lowland area. Many of the planned spur roads will be non-contributing due to flat, terrace locations and non-proximity to streams. Vegetation of cutbanks and fill slopes will contribute to a decreasing rate after year 3.

Distribution of the planned 7.2 miles of new road by lowland sub-basin is listed on the sub-basin sediment summary sheets.

LOWLAND ROADS

The Lower Mainstem Tolt sub-basin has the lowest road density in the watershed, and the lowest estimated sediment contribution from logging roads at 52 t/yr total. In addition, road usage which drives sediment rates up is limited to light general traffic on the logging roads and an asphalt county road. No mainline or secondary roads are located in the lower mainstem. Observed roads were lightly trafficked and had relatively low gradients. Localized problems may occur in areas frequented by local traffic near the town of Carnation.

The majority of sediment from roads in Stossel Creek is generated from the mainlines due to the heavy truck traffic (479 t/yr mainline out of 578 t/yr total). Relief culverts drain much of the mainline road that parallels the stream, but only 2 out of 16 were determined to deliver water and sediment to the stream. More sediment is generated from the pipeline mainline road through Stossel Creek than the Stossel Creek mainline. The road tread is generally wider on the pipeline, and long grades drain directly to crossings with little relief in between. Surfacing on the pipeline road suffers more from the high traffic levels than other parts of the mainline. The tread becomes deeply rutted during rainfall, and a plume of sediment from road ditch runoff was photographed entering the stream downstream of the crossing at field site #4. The cause of the rutting is likely due to the till parent material here, which is high in fines. Opportunities for entry exist at all stream crossings and where the road is within 100 feet of the stream. Roads occasionally parallel wetlands or streams in other parts of the lowland basin area, but the Stossel Creek road system is unique in the amount of road paralleling streams.

Except for the pipeline road through Stossel Creek, mainline surfacing appears adequate, although fines are abundant and easily airborne. The volume of fines available is to be expected from the heavy truck traffic, but it is unclear if the fines are generated from breakdown of the surfacing material or from fines pumping through the surfacing from the glacial parent material in the non-till areas.

Detailed road surveys were not conducted in the North Fork Creek drainage. Road density in this drainage is noticeably lower than in other portions of the lowlands, and the main secondary road is generally well buffered from streams. Experience from other road surveys would indicate that individual road crossings may locally generate a disproportionate amount of sediment, and it is expected that this road system would be similar. Road sediment delivery is highest from the mainlines in the lowlands, which are limited to singular stream crossings outside the Stossel Creek, North Fork and Crazy Creek areas.

Most of the surface drainage from the lower South Fork sub-basin flows from the Lynch Creek system. The large majority of sediments delivered to streams in the South Fork are from mainline road crossings, which account for virtually 87% of the total (727/833 t/yr). The majority of mainline entry points occur on Crazy Creek.

A significant obstruction to flow in Lynch Creek is located upstream of Lynch Lake at a failed road crossing.

HIGHLAND ROADS

The only roads above the dam field surveyed were portions of the north and south reservoir roads. A rough sediment budget of road surface sediment delivered from roads suggests that as much as 2400 t/yr is generated from roads. Background fine sediment input to the reservoir is estimated roughly at 1000 t/yr, indicating that roads may contribute two times as much sediment.

A contrast exists between the two reservoir roads. The T70 road appears to be the older or more stable road, with evidence of railroad logging and a number of log culverts and stream crossings, many of which were only partly functioning. Sediment is delivered to the reservoir from approximately 40 percent of the road. Both reservoir roads are located at the toe of the slope with evidence of groundwater and both channelized and unchannelized overland flow from the hillslopes and cutbanks above the roads draining to road culverts, ditches, and road surfaces.

Vintage large, non-corregated iron pipe have been used for culverts on the 50 reservoir road. The only wooden structure in place observed was a log bridge spanning Skookum Creek. Replacement of log culverts and crossings may have been necessary due to the high maintenance obvious on the road. Evidence of 5 debris events from streams has impacted the road recently, and necessaray maintenance activities keep the surfacing disturbed. The 50 road surface is mainly outsloped yet a grading berm allows concentration on the tread, and the close proximity of the road to the water essentially guarantees close to 100 percent delivery of runoff and sediment. The road was impassable 2.8 miles from the dam due to a debris event. This section of road is currently seeing increased traffic levels due to crossing failurers on the eastern portion of the road system surrounding the reservoir, and the segment was evaluated at a light logging truck rate. A lighter traffic level would reduce the estimate by 50 to 75 percent.

The Bobcat Creek road system was estimated to contribute a higher percentage (32%) of sediment than other parts of the sub-basin, in part due to the natural instability of the terrain, steeper slopes and road gradients. Sediment delivered to streams from these roads is estimated to be equivalent to a loss of 0.3 inches/yr from the road tread, ditches and cutbanks.

South aspect roads are generally in better shape than north aspect roads on both upper North and South Forks due to gentler slopes, relatively fewer stream crossings, and a greater length of road put-to-bed with full side-cast pulled back.

The Titicaca system corresponds topographically and aspect-wise with the Bobcat Creeks roads in the upper South Fork. Both systems experience road maintenance problems. A number of fill slope failures have initiated debris flows from these roads. Roads here have been water-barred for the last three years, and management tries to get to them twice a year. Delivery was not field checked and is assumed to be 33%. A thorough field inventory will help determine the effectiveness of waterbars in diverting road sediment from streams. Waterbars currently relieve the ditches.

The road system in the Titicaca basin was treated differently from the remaining upper North Fork roads with respect to estimating road sediment delivery. These are the youngest roads in the sub-basin being in the least accessable and steepest ground in the watershed, so cutbanks and slopes have less vegetation and the road gradients are steeper. An estimate of road sediment delivery indicates approximately 37% of upper Nork Fork road sediment is potentially generated from these roads.

Because there are close to 50 miles of light general use roads in the upper North Fork area, these roads collectively contribute the same amount of sediment annually as the Titicaca road system: approximately 37% of the estimate or 1670 tons. Additionally, 25 miles of non-use roads contribute roughly 580 tons or 13%. Mainlines contribute approximately 350 tons. The total of annual road sediment from the upper North Fork is estimated at 4500 tons.

CHANGING TRAFFIC LEVELS

Heavy traffic is expected to continue on the mainline roads. The existing road system, however, will experience a shifting use pattern dependent on harvest, maintenance, and recreational activities.

Changes in road sediment rates from alternative traffic use scenerios are tabulated on the road erosion worksheets (Form bb-3) for each road segment surveyed. The majority of roads were surveyed by calculating sediment yield for each entry point on the road. Worksheets for these surveys show changes in sediment rates under heavy traffic (>4 loaded logging trucks/day) and light traffic (1-4 loaded logging trucks/day) use conditions for each entry point rather than the change in rate averaged over the entire road segment on the remaining surveys.

Increasing traffic levels from light truck use to heavy truck use increases sediment erosion rates by a factor of 7 to 10. Increasing general use traffic will affect an erosion rate increase by a factor of approximately 15 for heavy use and 2 to 4 for light truck use.

Road managers can use the estimated and projected rates to predict the change in road sediment with changing traffic use patterns.

As stated in above, theoretically, the total annual basin sediment yield from roads could be reduced by 16 percent (1500 tons) by simply closing off all general use roads to traffic. Although closing all roads may not be practical for fire and other access, this example illustrates the importance of traffic use in road surface sediment production.

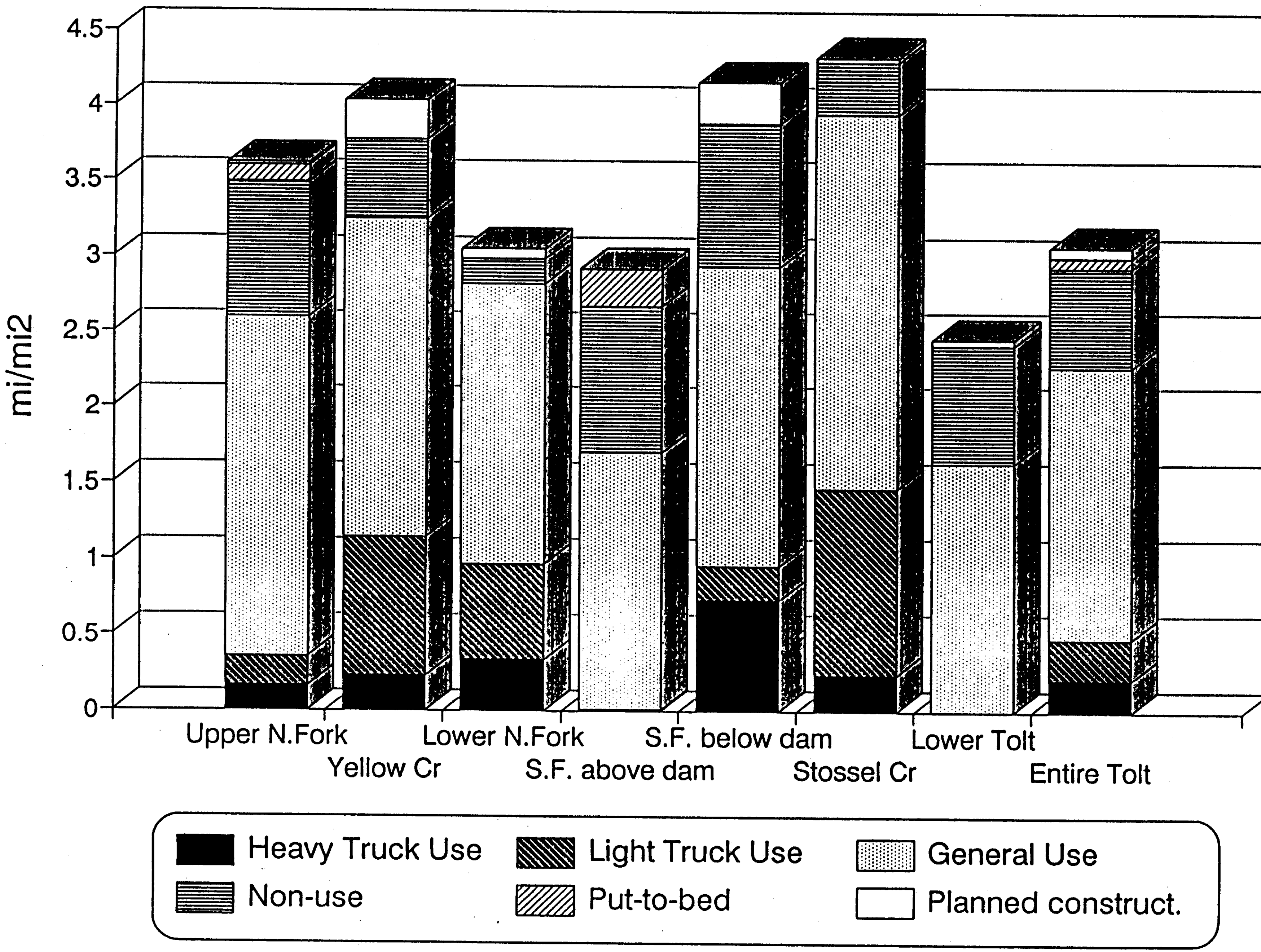
REFERENCES

Duncan, S. H., R. E. Bilby, J. W. Ward, J. T. Heffner, 1987, Transport of road-surface sediment through ephemeral stream channels, Water Resource Bulletin, 23, 113-119.

Raines, M. A., 1991, Sediment budget for the Grouse Creek basin, Humboldt County, California, M.S. Thesis, 110 pp., West. Wash. Univ., Bellingham.

Sullivan, K., et al., 1989, The generation and fate of road surface sediment in forested watersheds in Southwestern Washington, Forest Science, 35(2), pp. 453-468.

Tolt River Road Density by Sub-basin



TOLT WATERSHED ANALYSIS
Road Survey Summary

Road Class	Miles Surveyed	Miles in Road Class	Percent Roads Surveyed	Percent of Tolt Roads in Class	Estimated Sediment (t/yr)	Percent of Est. Sediment Total
Lowland						
Mainline	21.3	26.2	81	8.6	1959	20.9
Secondary	11.1	14.5	76	4.8	180	1.9
Light general	5.5	85.9	6.4	28.2	197	2.1
Non-use	0.76	25	3	8.2	30	0.3
Lowland Totals	38.7	151.6	25.5	49.7	2366	25.3
Highland						
Mainline	0	0	0	0.0	0	0.0
Secondary	2.8	12	23	3.9	1294	13.8
Light general	2.2	93.8	2.3	30.8	4592	49.1
Non-use	0	41.1	0	13.5	1050	11.2
Put-to-bed	0	6.7	0	2.2	58	0.6
Highland Totals	5	153.6	3.3	50.4	6994	74.7
Watershed Totals	43.7	305.2	14.3	100	9360	100

TOLT WATERSHED ANALYSIS
Road Density/Sediment Summary

Sub-basin	Road Miles	Basin Area (mi2)	Road Density (mi/mi2)	Est. Sediment (tons)	Sediment Per Area (t/mi2)	Sediment Per Mile (t/rd mi)
S. Fork above dam	38.8	19	2.0	2404	127	62
Upper N. Fork	105.5	33.1	3.2	4495	136	43
Yellow Cr	18.7	4.9	3.8	553	113	30
S. Fork below dam	50.2	12.9	3.9	833	65	17
Lower N. Fork	37.5	12.4	3.0	448	36	12
Stossel Cr	23.1	5.1	4.5	578	113	25
Lower Mainstem Tolt	31.3	10.5	3.0	52	5	2
Watershed Totals	305	98	3.1	9363	96	31

TOLT WATERSHED
CAUSAL MECHANISM REPORT
4/1/93

Known Road Hazard Areas:

RE 1 Highest contributing road crossing on Stossel Cr mainline. Road here bisects and parallels stream and wetland area. No relief culverts and almost 1000 feet of 8-10% grade draining either directly or indirectly to stream. Heavy traffic. Segment site #2 on field form.

RE 2 Relief culvert draining a 500' length of 10% road grade is perched directly above Index Creek immediately upstream of the 6170 road crossing. Light truck traffic road. Segment site #5 on field form.

RE 3 Section of 6170 road below the Index Creek crossing parallels the stream and wetland within a few feet. The road has been ditched closed due to garbage dumping occurring here in and near the wetland. Sediment due to traffic minimized with road closure, but garbage still in water.

RE 4 Two road segments drain to Index Creek tributary from over small fill at this crossing. Segment site #11 on field form.

RE 5 Recently reconstructed segment of road immediately adjacent to Stossel Creek wetland. Road requires lots of ballast to keep from sinking. Limited direct entry due to concave nature, but road lacks drainage for most of length. No cutbanks or fill slopes. This segment is an extension of the mainline and may see heavy truck traffic.

RE 6 Long length (1200') of high gradient mainline/pipeline road drains to tributary that joins Stossel Creek near the mouth. Fines from road surface likely to stay in suspension although there is good vegetation on road margins and fillslopes to trap coarser particles. Segment site #2 on field form.

RE 7 Small creek diverted into ditch; culvert insufficient. Segment site #5 on pipeline-mainline field form.

RE 8 Ditch draining segment west of crossing below the road is gullied to the stream. Mainline/pipeline road. Segment site #6 on field form.

RE 9 400' segment of mainline road draining to stream from ditch. Road is crowned or outsloped but entire outsloped edge is bermed allowing water to concentrate at crossing. Segment site #3 on field form.

RE 10 Lynch Creek: one of the two culverts plugged under washed-out crossing. Stream flows down road intermittently for approximately 1000 feet. Road is in non-use and most sediment has already been eroded from the road surface, but the water would more likely stay in the channel if the culvert was unplugged or removed. Road has insufficient lift. New road construction is expected at or near this crossing within the next few years. Site #1 on field form.

RE 11 Lynch Creek culvert at crossing aimed at and eroding opposite bank of stream. Crossing drains 3 road segments. Site #2 on field form.

RE 12 Long length (2100') of mainline road, crowned surface with ditch draining to Crazy Creek. Road has grading berm funneling some surface runoff through breach on upstream side. Sediment is ponded below the breach on a flood terrace above the active stream channel, which is probably inundated at high flows. Site #3 on field form.

RE 13 Gullying along length of access road to lower dam from water draining from T70 mainline. Direct entry checked on 3/22. Road drainage runs for several thousand feet on terrace surface, sometimes channelized sometimes not, but eventually infiltrates dropping sediment along the way. Contributes to some degree to groundwater seeps off sand cliff face above the South Fork on the right bank terrace below the dam. Runoff from approximately 0.5 mile of road and large helicopter landing site drains to this point. Site #1 on T70 road field form.

RE 14 Road paralleling reservoir within 200 feet constructed on alpine glacial outwash. 50 road field survey shows a 40 percent delivery rate. Old log culverts and crossings non or partially functional in places. Ditches filled with sediment from upslope in some places.

RE 15 Road paralleling reservoir within 200 feet constructed on andesite. Native surfacing in places. Delivery estimated at 95 percent from field checking. This section of road is currently seeing increased traffic levels due to crossing failures on the eastern portion of the road system surrounding the reservoir. Evidence of 5 debris events from streams is impacting the road, and necessary maintenance activities keep the surfacing disturbed. Road impassable 2.8 miles from dam due to culvert failure and debris event.

RE 16 Bobcat Creek road system. Eastern-most roads in the upper South Fork built in the late 70's on steep, north aspect slopes. Natural slope instability, steep road gradients, steep and unvegetated cutbanks and fills, and necessary road drainage maintenance activities contribute to chronic sediment production.

RE 17 Long length (1000') of mainline road drains to stream. Site #1 on field form.

RE 18 Long length (800') of mainline road drains to stream from road surface and ditch. Site #5 on field form.

RE 19 This section of mainline road is problematic. Active bank erosion on the north side of the river is creating bank instability where the road parallels the stream here. There may be a component of road drainage contribution to the problem. Field form site #6 has high direct entry potential and possibly contributes to downstream bank erosion in small stream from increased runoff. Sites #6,7, and 8 on field form.

RE 20 90 road crossing fill is failing. Some fill loss already occurred and entire fill subsiding. Cause indeterminant due to snow. Site #2 on field form.

RE 21 92 road segment. Water flowing over road between field sites #3 and 4. Road crossing completely washed out at site #4. Failure of old log crossing.

RE 22 Mid to lower-slope roads on steep slopes. Road less than 10 years old. Side cast is not well vegetated. Several slope failures initiated from roads.

RE 23 Stacked road system above Winter Lake. Cutbank and fill failures, and banks and fills not well vegetated. Delivery to streams or water is uncertain, needs field checking.

RE 24 Road 130 crossing. Road built on alluvial fan. The crossing has been replaced several times, the last with a structural steel bridge.

RE 25 Titicaca road system, similar to Bobcat Creek roads. Roads built in the 80's on steep, north aspect slopes. Natural slope instability, steep road gradients, steep and unvegetated cutbanks and fills, and necessary road drainage maintenance activities contribute to chronic sediment production.

RE 26 Titicaed Creek roads. Cut banks from long grade on west side of creek intercept much groundwater adding to the road surface runoff in addition to cutbank and ditch erosion. Maintenance has re-sized culverts to 3' to handle flow. Raveling of fill slopes on east side of stream.

TOLT WATERSHED ANALYSIS
Road Sediment Summary

Sub-basin: South Fork above dam

3/24/93

Road Class	Erosion Rate t/ac/yr	Erosion Hazard H/M/L	Road Miles	Road Prism Width	Road Prism Acres	Est. Sediment Yield t/yr
Lowland roads						
Mainlines	20.6	L		30	0.0	0
Secondary	2.4	L		30	0.0	0
Light general	0.5	L		25	0.0	0
Light general-new	1.5	L		25	0.0	0
Non-use	0.4	L		25	0.0	0
To be built						
Highland roads					0.0	0
Secondary	9.6	L	0.1	30	0.4	3
Light general	8	L	9.6	35	40.7	326
Reservoir s rd-andesite	77	M	3	35	12.7	980
Reservoir rd-alluvium	4	L	3.5	35	14.8	59
Non-use	5.4	L	10.4	35	44.1	238
Put-to-bed	2	L	3.2	35	13.6	27
Titicaca & Bobcat Cr rds						
Light general	20	L	6.2	40	30.1	601
Non-use	13.7	L	2.5	40	12.1	166
Put-to-bed	2	L	0.3	40	1.5	3
Sub-basin Totals			38.8		170	2404

TOLT WATERSHED ANALYSIS
Road Sediment Summary

Sub-basin: Upper North Fork

Road Class	Erosion Rate t/ac/yr	Erosion Hazard H/M/L	Road Miles	Road Prism Width	Road Prism Acres	Est. Sed. Yield t/yr
Lowland roads						
Mainlines	20.6	L	4.7	30	17.1	352
Secondary	2.4	L		30	0.0	0
Light general	0.5	L		25	0.0	0
Light general-new	1.5	L		25	0.0	0
Non-use	0.4	L		25	0.0	0
To be built			0.7			
Highland roads						
Secondary	9.6	L	5.9	30	21.5	206
Light general	8	L	49.1	35	208.3	1666
Reservoir rd-andesite	19	L		35	0.0	0
Reservoir rd-alluvium	15	L		35	0.0	0
Non-use	5.4	L	25.5	35	108.2	584
Put-to-bed	2	L	2.6	35	11.0	22
Titicaca & Bobcat Cr rds						
Light general	20	L	17.1	40	82.9	1658
Non-use	13.7	L		40	0.0	0
Put-to-bed	2	L	0.6	40	2.9	6
Sub-basin Totals			106.2		452	4495

TOLT WATERSHED ANALYSIS
Road Sediment Summary

Sub-basin: Yellow Creek

Road Class	Erosion Rate t/ac/yr	Erosion Hazard H/M/L	Road Miles	Road Prism Width	Road Prism Acres	Est. Sed. Yield t/yr
Lowland roads						
Mainlines	20.6	L	1.1	30	4.0	82
Secondary	2.4	L	1.5	30	5.5	13
Light general	0.5	L		25	0.0	0
Light general-new	1.5	L	2.1	25	6.4	10
Non-use	0.4	L		25	0.0	0
To be built			1.3			
Highland roads						
Secondary	9.6	L	3.0	30	10.9	105
Light general	8	L	8.3	35	35.2	282
Reservoir rd-andesite	19	L		35	0.0	0
Reservoir rd-alluvium	15	L		35	0.0	0
Non-use	5.4	L	2.7	35	11.5	62
Put-to-bed	2	L		35	0.0	0
Titicaca & Bobcat Cr rds						
Light general	20	L		40	0.0	0
Non-use	13.7	L		40	0.0	0
Put-to-bed	2	L		40	0.0	0
Sub-basin Totals			20.0		73	553

TOLT WATERSHED ANALYSIS
Road Sediment Summary

Sub-basin: Stossel Creek

Road Class	Erosion Rate t/ac/yr	Erosion Hazard H/M/L	Road Miles	Road Prism Width	Road Prism Acres	Est. Sed. Yield t/yr
Lowland roads						
Mainlines	20.6	L	6.4	30	23.3	479
Secondary	2.4	L	1.1	30	4.0	10
Secondary-rebuilt	35.9	L	0.95	15	1.7	62
Light general	0.5	L	10.8	25	32.7	16
Light general-new	1.5	L	1.9	25	5.8	9
Non-use	0.4	L	1.9	25	5.8	2
To be built			0.2			
Highland roads						
Secondary	9.6	L		30	0.0	0
Light general	8	L		35	0.0	0
Reservoir rd-andesite	19	L		35	0.0	0
Reservoir rd-alluvium	15	L		35	0.0	0
Non-use	5.4	L		35	0.0	0
Put-to-bed	2	L		35	0.0	0
Titicaca & Bobcat Cr rds						
Light general	20	L		40	0.0	0
Non-use	13.7	L		40	0.0	0
Put-to-bed	2	L		40	0.0	0
Sub-basin Totals			23.3		73	578

TOLT WATERSHED ANALYSIS
Road Sediment Summary

Sub-basin: Lower Mainstem Tolt

Road Class	Erosion Rate t/ac/yr	Erosion Hazard H/M/L	Road Miles	Road Prism Width	Road Prism Acres	Est. Sed. Yield t/yr
Lowland roads						
Mainlines	20.6	L		30	0.0	0
Secondary	2.4	L		30	0.0	0
Light general	0.5	L	20.7	25	62.7	31
Light general-new	1.5	L	2.2	25	6.7	10
Non-use	0.4	L	8.4	25	25.5	10
To be built			0.5			
Highland roads						
Secondary	9.6	L		30	0.0	0
Light general	8	L		35	0.0	0
Reservoir rd-andesite	19	L		35	0.0	0
Reservoir rd-alluvium	15	L		35	0.0	0
Non-use	5.4	L		35	0.0	0
Put-to-bed	2	L		35	0.0	0
Titicaca & Bobcat Cr rds						
Light general	20	L		40	0.0	0
Non-use	13.7	L		40	0.0	0
Put-to-bed	2	L		40	0.0	0
Sub-basin Totals			31.8		95	52

TOLT WATERSHED ANALYSIS
Road Sediment Summary

Sub-basin: South Fork below dam

Road Class	Erosion Rate t/ac/yr	Erosion Hazard H/M/L	Road Miles	Road Prism Width	Road Prism Acres	Est. Sed. Yield t/yr
Lowland roads						
Mainlines	20.6	L	9.7	30	35.3	727
Secondary	2.4	L	3	30	10.9	26
Light general	0.5	L	16.1	25	48.8	24
Light general-new	1.5	L	8.9	25	27.0	40
Non-use	0.4	L	12.5	25	37.9	15
To be built			3.6			
Highland roads						
Secondary	9.6	L		30	0.0	0
Light general	8	L		35	0.0	0
Reservoir rd-andesite	19	L		35	0.0	0
Reservoir rd-alluvium	15	L		35	0.0	0
Non-use	5.4	L		35	0.0	0
Put-to-bed	2	L		35	0.0	0
Titicaca & Bobcat Cr rds						
Light general	20	L		40	0.0	0
Non-use	13.7	L		40	0.0	0
Put-to-bed	2	L		40	0.0	0
Sub-basin Totals			53.8		160	833

TOLT WATERSHED ANALYSIS
Road Sediment Summary

Sub-basin: Lower N. Fork

Road Class	Erosion Rate t/ac/yr	Erosion Hazard H/M/L	Road Miles	Road Prism Width	Road Prism Acres	Est. Sed Yield t/yr
Lowland roads						
Mainlines	20.6	L	4.3	30	15.5	319
Secondary	2.4	L	8.0	30	28.9	69
Light general	0.5	L	15.8	25	47.7	24
Light general-new	1.5	L	7.4	25	22.3	33
Non-use	0.4	L	2.2	25	6.7	3
To be built			0.9			
Highland roads					0	0
Secondary	9.6	L			0	0
Light general	8	L			0	0
Reservoir rd-andesite	19	L				
Reservoir rd-allluvium	15	L			0	0
Non-use	5.4	L			0	0
Put-to-bed	2	L			0	0
Titicaca & Bobcat Cr rds		L			0	0
Light general	20	L			0	0
Non-use	13.7					
Put-to-bed	2	L			0	0
Sub-basin Totals			38.5		121.1	448

TOLT WATERSHED ANALYSIS
CONDENSED ROAD COMMENTS
3/30/93

1. **Projected road construction plans and estimated impacts.**

   Added section on New Road Construction in summary. Includes location and amount of projected road construction with conservative estimates of additional sediment contribution for next 3 years.

2. **Incorporation of hillslope surface erosion and mass wasting information into the road analysis.**

   Comparing the different sources of fine sediment is most appropriate to the synthesis phase. The resource assessment reports would be the likely format for this comparison.

3. **Confidence in analysis due to lack of field verification in highland, or estimated increase in confidence with more field time.**

   Expanded confidence discussion. Split level of confidence in highland to moderate for sediment estimate and low for identifying specific causal mechanisms of erosion.

4. **Roads rated low and no consideration given to road density. Level 1 method inadequate for Level 2 and underrepresents potential damage to public resources.**

   The March 10 summary and supporting tabulations address this directly by focusing the analysis on the cumulative sediment estimated from all roads.

5. **Procedure for pending road inventory. (Causal Mechanism Report says "see module report for inventory plan). Incomplete and inadequate road survey; many problem areas missed. How to incorporate future survey to insure results addressed in prescriptions. (In her comments, Sue Perkins suggests that a procedure for handling these areas needs to be discussed with the whole group).**

   The intention of this analysis is to sample the road system in order to provide causal mechanisms of road erosion specific to the Tolt. Due to weather, the higher elevation areas were not adequately sampled. Wording was added to clarify what information a management road survey would provide and how that information would be used to prioritize maintenance efforts. The review group will wait to see how the prescription team will tie a road survey into the prescriptions.

6. **Dominant factors affecting road related surface erosion in the basin.**

   Wording has been added to emphasize main variables and site-specific factors where we have that information.

7. **What is the quantity of road sediment directly delivered to the channel on an annual basis?**

   Estimates are summarized in the Results section of the write-up and on the Road Sediment Summary sheets for each sub-basin by road class.

8. **Distribution of sediment type produced from roads.**

   Added sentence in first paragraph on sediment sizes measured from road surface erosion.

m bb-3. Road Erosion Worksheet TOLT WATERSHED
d Segment: Pipeline mainline from 26N7ES26 to Reg. pond
-basin: Stossel Cr, Lower N. Fork
al Segment Length: 21800

				CUTSLOPE (ECe +)				FILLSLOPE (EFe +)				DITCH (EDe +)			
(1) oad ment/ Site	(2) Road Age yrs	(3) Rock Type	(4) Basic Erosion Rate-EB	(5) Value EC EB*0.40	(6) % Veg	(7) Veg Factor	(8) ECe	(9) Value EF EB*0.20	(10) % Veg	(11) Veg Factor	(12) EFe	(13) Value ED EB*0.05	(14) Armor Y/N	(15) Armor Factor	(16) EDe
1	>3	Till	60	24.0	No cut	0	0.0	12.0	100	0.18	2.2	3.0	Y	0.95	2.9
2	>3	Till	60	24.0	No cut	0	0.0	12.0	100	0.18	2.2	3.0	Y	0.95	2.9
3	>3	Till	60	24.0	No cut	0	0.0	12.0	100	0.18	2.2	3.0	Y	0.95	2.9
4	>3	Ice marg.	60	24.0	No cut	0	0.0	12.0	100	0.18	2.2	3.0	Y	0.95	2.9
5	>3	Ice marg.	60	24.0	75	0.37	8.9	12.0	nofill	0	0.0	3.0	Y	0.95	2.9
6	>3	Till	60	24.0	97	0.18	4.3	12.0	100	0.18	2.2	3.0	Y	0.95	2.9
7	>3	Vol/sed rx	30	12.0	50	0.37	4.4	6.0	100	0.18	1.1	1.5	Y	0.95	1.4
8	>3	Vol/sed rx	30	12.0	100	0.18	2.2	6.0	nofill	0	0.0	1.5	Y	0.95	1.4

(ETe x Use = ETec) = ERe x ERd = ER

	SURFACING			TRAFFIC				DELIVERY				
	(17) Value ET EB*0.35	(18) Surface Factor	(19) ETe	(20) Road Use	(21) Use Factor	(22) ETec	(23) ERe	(24) Buffer Factor N = 0	(25) Direct Entry %/100	(26) ERd	(27) Overall ER Rate t/ac/yr	(28) Hazard Rating H/M/L
1	21.0	0.2	4.2	H	50	210.0	215	0	0.7	0.7	151	H
2	21.0	0.2	4.2	H	50	210.0	215	0	0.7	0.7	151	H
3	21.0	0.2	4.2	H	50	210.0	215	0	0.8	0.8	172	H
4	21.0	0.2	4.2	H	50	210.0	215	0	0.8	0.8	172	H
5	21.0	0.2	4.2	H	50	210.0	222	0	1	1.0	222	H
6	21.0	0.2	4.2	H	50	210.0	219	0	1	1.0	219	H
7	10.5	0.2	2.1	H	50	105.0	112	0	1	1.0	112	M
8	10.5	0.2	2.1	H	5	10.5	14	0	1	1.0	14	L
								Total Segment ER =			27	L

GAMING (29) ER Heavy Traffic	(30) ER Light Traffic	(31) Segment Length ft	(32) Road Prism Width/ft	(33) Road Prism Acres	(34) Road Sediment tons/yr
151	18	400	35	0.3	48
151	18	1200	35	1.0	145
172	21	500	35	0.4	69
172	21	350	30	0.2	41
222	33	200	30	0.1	31
219	30	500	35	0.4	88
112	17	250	35	0.2	22
109	14	220	35	0.2	2
Total sediment from segment					448

6H

#6 GULLIED RELIEF
DRAIN DITCH
BELOW ROAD
TO STREAM
WEST SIDE OF
CROSSING

1-5- ESP 2

Form 1. Road Segments Para[illegible]ing Streams Within 200 Ft.

WAU TOLT Segment Type 6H Seg Map Number Pipeline start 26N 7E - 26/25

Road Position TILL PLAIN Use HEAVY TRUCK & GEN. TRAFFIC Parent Material TILL / ICE MARGINAL / VOL. 9 SED. Ry

Map Point	Surface Type	Surf. Depth	Cutslope-Veg %	Fillslope-Veg %	Ditch	Road Age	Rutting or Gullying?	Length	Width	Configuration (insloped / outsloped / crown / berm)	Direct Entry?	Pathway	How Far?	Stream Type	Gradient Comments
1	C.R.	6"		100%	VEG		very slight	400'	15'	crown	Y	hillslope	5-10ft		center 200'. Flat. 100' either side 30% slope cross culvert - wetland
2	C.R.	6"		100%	VEG. + rock armor		very slight	1200'	15'	crown	Y	hillslope	5-10ft		wetland; East 100ft 15% slope. center 150' int - west 950' 15-20% slope; cross culvert
3	C.R.	6"		100%	VEG		none observed	500'	15'	crown	Y	hillslope	5-10ft		wetland; east 100' 15% slope. center 300' [illegible] west 100' 15% slope; cross culvert
4	C.R.	6"		100%	VEG		very slight	350'	15'	crown	yes	ditch			shotgun culvert; direct entry coming from ditch [illegible] on south side of rd. See reverse →
5	C.R.	6"	75%		some veg.		slight	200'	15'	inslope	yes	cut-slope			this is a small creek that runs in the ditch; culvert insufficient
6	C.R.	6"	97%	100%	VEG		slight	500'	15'	crown	yes	ditch			shotgun culvert; eastern side of creek ditches diverted - NW ditch diverted 100 above stream crosses road & from here gullied channel to stream
7	C.R.	6"	50%	100% - [illegible] chute	VEG + ROCK armor		slight to moderate	250'	15'	crown + outsloped	yes	ditch			see reverse south See reverse →
8	C.R.	6"	100%		VEG		slight	220'	15'	crown	yes	ditch			Approx. 20ft. paved [illegible] side of bridge; no ditch diversion on south side of rd. travels all the way to river
Total															

ditching on south side of rd. within 5 ft. of rd. surface } to #5
" " north side of rd. within 15 ft. of rd. surface }

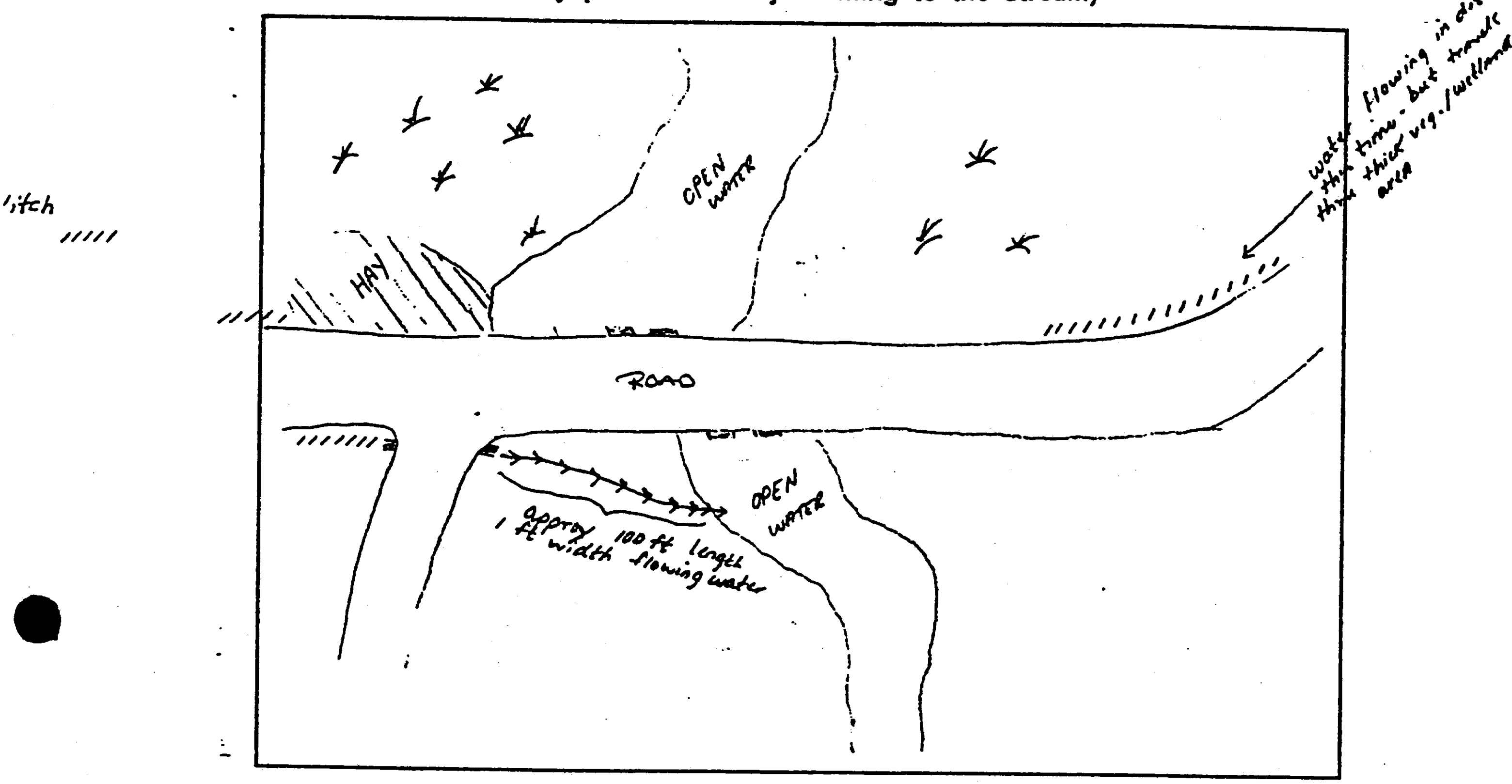
Form 2. Road Segments Draining to Flowing Streams

Road Crossing Number 4 (pipeline) **Stream Type** ______

~~Soil Type~~ ______

↑N

Sketch the Road /Stream Configuration
(Include only portion directly draining to the stream)



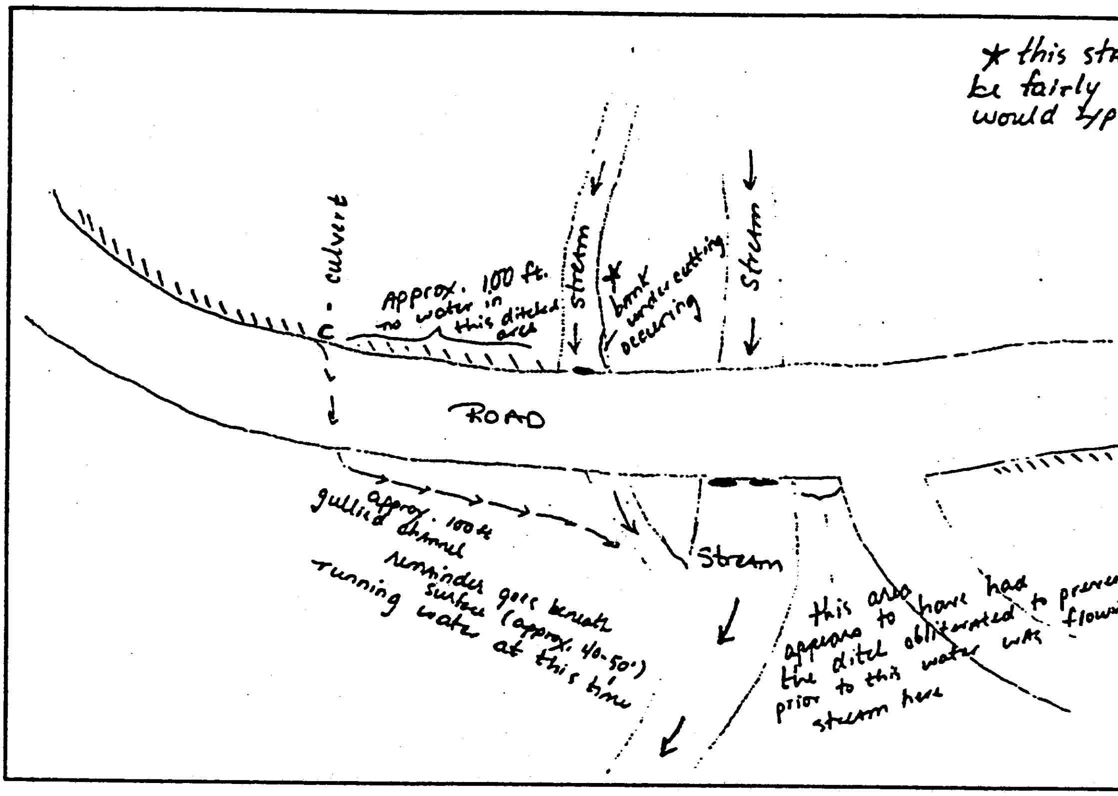
	Segment 1	Seg 2 (If needed)	Seg 3 (If needed)
Surfacing Type			
Depth of Lift			
Cutslope Veg %			
Fillslope Veg %			
Ditch Condition			
Road Age			
Length			
Width			
Configuration			
Expected Use			
GRADIENT ~~Comments~~			
COMMENTS			
TOTAL SEDIMENT			

Form 2. Road Segments Draining to Flowing Streams

Road Crossing Number 6 pipeline **Stream Type** ______
~~Soil Type~~ ______

Sketch the Road /Stream Configuration
(Include only portion directly draining to the stream)

\\\\\ ditch



	Segment 1	Seg 2 (If needed)	Seg 3 (If needed)
Surfacing Type			
Depth of Lift			
Cutslope Veg %			
Fillslope Veg %			
Ditch Condition			
Road Age			
Length			
Width			
Configuration			
Expected Use			
Gradient			
Comments			
TOTAL SEDIMENT			

6H

rm bb-3. Road Erosion Worksheet TOLT WATERSHED
ad Segment: Stossel Cr Rd
b-basin: Stossel Cr
tal Segment Length (ft) 13500

				CUTSLOPE			ECe +	FILLSLOPE			EFe +	DITCH			EDe +
(1) Road gment/ Site	(2) Road Age yrs	(3) Rock Type	(4) Basic Erosion Rate-EB	(5) Value EC EB*0.40	(6) % Veg	(7) Veg Factor	(8) ECe	(9) Value EF EB*0.20	(10) % Veg	(11) Veg Factor	(12) EFe	(13) Value ED EB*0.05	(14) Armor Y/N	(15) Armor Factor	(16) EDe
1	>3	Alluvium	50	20.00	100	0.18	3.60	10.00	100	0.18	1.80	2.50	Y	0.95	2.38
2	>3	Alluvium	50	20.00	100	0.18	3.60	10.00	100	0.18	1.80	2.50	Y	0.95	2.38
3	>3	Alluvium	50	20.00	80	0.18	3.60	10.00	100	0.18	1.80	2.50	Y	0.95	2.38
4	>3	Alluvium	50	20.00	No cut	0	0.00	10.00	100	0.18	1.80	2.50	Y	0.95	2.38
5	>3	Alluvium	50	20.00	85	0.18	3.60	10.00	100	0.18	1.80	2.50	Y	0.95	2.38
6	>3	Alluvium	50	20.00	100	0.18	3.60	10.00	100	0.18	1.80	2.50	Y	0.95	2.38
7	>3	Alluvium	50	20.00	100	0.18	3.60	10.00	100	0.18	1.80	2.50	Y	0.95	2.38
8	>3	Alluvium	50	20.00	100	0.18	3.60	10.00	100	0.18	1.80	2.50	Y	0.95	2.38
9	>3	Alluvium	50	20.00	95	0.18	3.60	10.00	100	0.18	1.80	2.50	Y	0.95	2.38
10	>3	Alluvium	50	20.00	No cut	0	0.00	10.00	100	0.18	1.80	2.50	Y	0.95	2.38

(ETe x Use = ETec) = ERe x ERd = ER

	SURFACING			TRAFFIC				DELIVERY				
	(17) Value ET EB*0.35	(18) Surface Factor	(19) ETe	(20) Road Use	(21) Use Factor	(22) ETec	(23) ERe	(24) Buffer Factor N = 0	(25) Direct Entry %/100	(26) ERd	(27) Overall ER Rate t/ac/yr	(28) Hazard Rating H/M/L
1	17.50	0.2	3.50	H	50	175.00	183	0	0.7	0.7	128	M
2	17.50	0.2	3.50	H	50	175.00	183	0	0.8	0.8	146	MH
3	17.50	0.2	3.50	H	50	175.00	183	0	0	0.0	0	L
4	17.50	0.2	3.50	H	50	175.00	179	0	1	1.0	179	H
5	17.50	0.2	3.50	H	50	175.00	183	0	0.5	0.5	91	M
6	17.50	0.2	3.50	H	50	175.00	183	0	0.5	0.5	91	M
7	17.50	0.2	3.50	H	50	175.00	183	0	0.5	0.5	91	M
8	17.50	0.2	3.50	H	50	175.00	183	0.1	0	0.1	18	L
9	17.50	0.2	3.50	H	50	175.00	183	0	1	1.0	183	H
10	17.50	0.2	3.50	H	50	175.00	179	0.1	0.4	0.5	82	M
								Total Segment ER =			24.2	L

GAMING					
(29) ER Heavy Traffic	(30) ER Light Traffic	(31) Segment Length ft	(32) Road Prism Width/ft	(33) Road Prism Acres	(34) Road Sediment tons/yr
128	18	420	30	0.289	37
146	20	942	35	0.757	111
0	0	3170	30	2.183	0
179	22	50	25	0.029	5
91	13	200	30	0.138	13
91	13	200	30	0.138	13
91	13	200	30	0.138	13
18	3	150	30	0.103	2
183	25	75	30	0.052	9
82	10	400	25	0.23	19
Total sediment from segment					221

Form bb-3. Road Erosion Worksheet TOLT WATERSHED

Road Segment: Rebuilt section of upper Stossel Cr road

Sub-basin: Stossel Creek

Total Segment Length: 4700

ECe + EFe + EDe +

(1) Road Segment/ Site	(2) Road Age yrs	(3) Rock Type	(4) Basic Erosion Rate-EB	CUTSLOPE (5) Value EC EB*0.40	(6) % Veg	(7) Veg Factor	(8) ECe	FILLSLOPE (9) Value EF EB*0.20	(10) % Veg	(11) Veg Factor	(12) EFe	DITCH (13) Value ED EB*0.05	(14) Armor Y/N	(15) Armor Factor	(16) EDe
11	1	Reces outwsh	110	44.0	---	0	0.0	22.0	---	0	0.0	5.5	N	1	5.5
12	1	Reces outwsh	110	44.0	---	0	0.0	22.0	---	0	0.0	5.5	N	1	5.5
13	1	End of spur		0.0			0.0	0.0			0.0	0.0			0.0
		road segment		0.0			0.0	0.0			0.0	0.0			0.0
				0.0			0.0	0.0			0.0	0.0			0.0
				0.0			0.0	0.0			0.0	0.0			0.0
				0.0			0.0	0.0			0.0	0.0			0.0
				0.0			0.0	0.0			0.0	0.0			0.0

(ETe x Use = ETec) = ERe x ERd = ER

SURFACING (17) Value ET EB*0.35	(18) Surface Factor	(19) ETe	TRAFFIC (20) Road Use	(21) Use Factor	(22) ETec	(23) ERe	DELIVERY (24) Buffer Factor N = 0	(25) Direct Entry %/100	(26) ERd	(27) Overall ER Rate t/ac/yr	(28) Hazard Rating H/M/L
38.5	0.6	23.1	L	5	115.5	121	0.5	0	0.5	60	M
38.5	0.6	23.1	L	5	115.5	121	0	1	1.0	121	H
0.0		0.0			0.0	0		0	0.0	0	
0.0		0.0			0.0	0			0.0	0	
0.0		0.0			0.0	0			0.0	0	
0.0		0.0			0.0	0			0.0	0	
0.0		0.0			0.0	0			0.0	0	
0.0		0.0			0.0	0			0.0	0	

Total Segment ER = 39

GAMING (29) ER Heavy Traffic	(30) ER Light Traffic	(31) Segment Length ft	(32) Road Prism Width/ft	(33) Road Prism Acres	(34) Road Sediment tons/yr
580	60	2800	15	1.0	58
1161	121	100	15	0.0	4
0	0			0.0	0
0	0			0.0	0
0	0			0.0	0
0	0			0.0	0
0	0			0.0	0
0	0			0.0	0

Total sediment from segment 62

O.S. - old surfacing

Form 1. Road Segments Paralleling Streams Within 200 Ft.

WAU: Tolt River Segment Type: 6H Seg Map Number: Stossel Crk. Rd. 26N 7E 23-24

Road Position: MID-LOW SLOPE Use: H Parent Material: TILL & OUTWASH SANDS & GRAVELS

Map Point	Surface Type	Surf. Depth	Cutslope-Veg %	Fillslope-Veg %	Ditch	Road Age	Rutting or Gullying?	Length-ft.	Width-ft.	Configuration	Direct Entry?	Pathway	How Far?	Stream Type	Comments
	Road Characteristics							Area			Drainage				
1	C.R.	6"	100%	100%	VEG.	>3	very slight	420	15		YES	ditch fillslope	70%		veg. filters
2	C.R.	6"	100%	100%	VEG.	↓	slight	942	15		YES	tread + fill	80%		water seeping from cut bank; no cross draining
3	C.R.	6"	80%	100%	rock armor			.6 mile	15		NO		0%		relief culvert - farther than 200 ft. from stream
								↓							~~IIII~~ /// rd. low gradient
4	C.R.	6"	—	100%	rock armor		slight	50	15		Y	tread + fill			
	C.R.	6"			rock armor		slight	.2 mile	15						// # RELIEF CULVERTS
5	C.R.	6"	85%	100%	rock armor		slight to moderate	200	15	CROWN	Y	ditch	50%		
6	C.R.	6"	100%	100%	rock armor		slight	200	15		NO	forest floor	50%		relief culvert w/in 60 ft of stream
7	C.R.	6"	100%	100%	VEG		slight	200	15	CROWN	Y	ditch	50%		
	C.R.	6"			rock armor		slight	.4 mile	15						/// (.4 mile) # RELIEF CULVERTS
8	C.R.	6"	100%	100%	VEG		slight	150	15	CROWN	NO	ditch + tread	50%		no defined channel - 100 ft. from stream
9	C.R.	6"	95%	100%	veg. + rock armor		very slight	75	15	CROWN	Y				appears to be newly created channel
	C.R.	6"					slight	.25 mile	15						// (.25 mile) # RELIEF CULVERTS
10	C.R.	6"	—	100%	rock armor	↓	very slight	250 150	15	Crown level	10% 100%				rd. crosses s. crk. some filtering thru fillslope
11	O.S.	2"-4"	—	—	most of rd. brushed w/ ferns & alders	intermittent ditching	yes - rd surface quite soft	.95 mile	15						#11 beginning of spur segment recently graded; 2-4" surfacing
12	↓	2"-4"	↓	↓							YES	ditches + tread	100 ft.		possible #12 culvert almost full - almost completely buried
13	↓	2"-4"	↓	↓				↓	↓						#13 - end of spur rd. segment
Total															

13,550 ft

4700 ft

6 L

orm bb-3. Road Erosion Worksheet TOLT WATERSHED
oad Segment: 6170 Rd Stossel-Index Creeks loop
ub-basin: Stossel Cr
otal Segment Length: 16900

				ECe +				EFe +				EDe +			
				CUTSLOPE				FILLSLOPE				DITCH			
(1) Road egment/ Site	(2) Road Age yrs	(3) Rock Type	(4) Basic Erosion Rate-EB	(5) Value EC EB*0.40	(6) % Veg	(7) Veg Factor	(8) ECe	(9) Value EF EB*0.20	(10) % Veg	(11) Veg Factor	(12) EFe	(13) Value ED EB*0.05	(14) Armor Y/N	(15) Armor Factor	(16) EDe
1	>3	Reces outwsh	50	20.0	---	0	0.0	10.0	80	0.18	1.8	2.5	---	0	0.0
2	>3	Reces outwsh	50	20.0	80	0.18	3.6	10.0	90	0.18	1.8	2.5	Y	0.95	2.4
3	>3	Reces outwsh	50	20.0	80	0.18	3.6	10.0	90	0.18	1.8	2.5	Y	0.95	2.4
4	>3	Reces outwsh	50	20.0	---	0	0.0	10.0	50	0.37	3.7	2.5	Y	0.95	2.4
5	>3	Reces outwsh	50	20.0	---	0	0.0	10.0	80	0.18	1.8	2.5	Y	0.95	2.4
6	>3	Vol/sed rx	30	12.0	20	0.63	7.6	6.0	80	0.18	1.1	1.5	Y	0.95	1.4
7	>3	Vol/sed rx	30	12.0	80	0.18	2.2	6.0	80	0.18	1.1	1.5	Y	0.95	1.4
8	>3	Ice margin	60	24.0	100	0.18	4.3	12.0	100	0.18	2.2	3.0	Y	0.95	2.9
9	>3	Ice margin	60	24.0	100	0.18	4.3	12.0	100	0.18	2.2	3.0	Y	0.95	2.9
10	>3	Ice margin	60	24.0	100	0.18	4.3	12.0	80	0.18	2.2	3.0	Y	0.95	2.9
11	>3	Ice margin	60	24.0	100	0.18	4.3	12.0	100	0.18	2.2	3.0	Y	0.95	2.9
12	>3	Ice margin	60	24.0	100	0.18	4.3	12.0	100	0.18	2.2	3.0	Y	0.95	2.9

				(ETe x Use = ETec)			= ERe			x ERd	= ER	
	SURFACING			TRAFFIC				DELIVERY				
	(17) Value ET EB*0.35	(18) Surface Factor	(19) ETe	(20) Road Use	(21) Use Factor	(22) ETec	(23) ERe	(24) Buffer Factor N = 0	(25) Direct Entry %/100	(26) ERd	(27) Overall ER Rate t/ac/yr	(28) Hazard Rating H/M/L
1	17.5	0.4	7.0	L	5	35.0	37	0	0.8	0.8	29	L
2	17.5	0.4	7.0	L	5	35.0	43	0	0	0.0	0	L
3	17.5	0.4	7.0	L	5	35.0	43	0	0	0.0	0	L
4	17.5	0.4	7.0	L	5	35.0	41	0	0.8	0.8	33	L
5	17.5	0.4	7.0	L	5	35.0	39	0	0.5	0.5	20	L
6	10.5	0.4	4.2	L	5	21.0	31	0	1	1.0	31	L
7	10.5	0.4	4.2	L	5	21.0	26	0	0	0.0	0	L
8	21.0	0.4	8.4	L	5	42.0	51	0	0.7	0.7	36	L
9	21.0	0.4	8.4	L	5	42.0	51	0	1	1.0	51	L
10	21.0	0.4	8.4	L	5	42.0	51	0	1	1.0	51	L
11	21.0	0.4	8.4	L	5	42.0	51	0	1	1.0	51	L
12	21.0	0.4	8.4	L	5	42.0	51	0	1	0.7	36	L
								Total Segment ER =			6	L

GAMING					
(29) ER Heavy Traffic	(30) ER Light Traffic	(31) Segment Length ft	(32) Road Prism Width/ft	(33) Road Prism Acres	(34) Road Sediment tons/yr
281	29	100	20	0.0	1
0	0	75	30	0.1	0
0	0	100	30	0.1	0
285	33	200	25	0.1	4
177	20	100	25	0.1	1
220	31	500	35	0.4	12
0	0	500	25	0.3	0
301	36	100	30	0.1	2
429	51	150	30	0.1	5
429	51	100	30	0.1	4
429	51	300	35	0.2	12
301	36	1000	25	0.6	21
Total sediment from segment					63

Form 3. Road Segments With Erosion Indicators

STOSSEL CR.

WAU TOLT **Seg Map Number** 6100 SPUR **Segment Type** ______ 3.2 mi

Road Position OUTWASH PLAIN **Use** 6 G L **Indicator** ______

Surface Type RG **Surf. Depth** 4-6 **Road Age** >3 **Parent Material** GLACIAL

RIVER GRAVEL

	ROAD GRADIENT %	Cutslope-Veg %	Fillslope-Veg %	Ditch	Rutting or Gullying ~~of Ditch?~~	Length	Width	Configuration	Direct Entry?	Stream Type	Comments
1 RO	0-5%	/	80+	NONE		100'	12'	OUT	Y		ENTRY OVER FILL
2 RO	0-4	20- MOSTLY	90+	GRASS	POT HOLES			OUT	NO		ROAD BTWN 2-3
3 RO	↓	80+	↓	↓	↓			OUT	NO		3-4 RELIEF CULVERTS
											DRAIN CUT & DITCH ONLY ROAD OUTSLOPED
4 RO	1-2%	/	50+	VEG	RUTS/POTS	200'	15'	OUT	Y		MAJOR STREAM XING
											LG ROCK ON FILL
											12' CULVERT
											SURFACE RO MOSTLY
											FILTERED THROUGH FILL
											ROCK & VEG
5	5%	/	GRASS ROCK	GRASS	SLIGHT	100'	15'	CROWN + OUT	Y		ENTRY OVER FILL - TO SPUR UPPER ROAD DR... RD. CLOS... TRENCH W/IN
6	10%	5-30	80+	SOME VEG	RILLS RUTS	500'	15'	CROWN + IN	Y		RELIEF CULVERT
6/SG											20' OF STREAM PERCHED
											ABOVE ON SLOPE
7	10%	80+	80+	GRASS	RILLS RUTS	500'	15'	LEVEL	NO		FLUME ON CULVERT
8	5%	100	100	GRASS	RILLS	100'	15'	OUT	Y		MOST ENTRY FILTERED
											THROUGH GRASS ON FILL
											& DITCHES
9	5%	100	100	GRASS	RILLS	150'	15'	CROWN	Y		
10	5%	100	60-100	GRASS	RILLS POTS	100'	15'	CROWN	Y		ENTRY THROUGH FILL & DITCH
11	5%	100	100	GRASS	RILLS POTS	300'	15'	OUT	Y		2 ROAD SEG. DRAIN HERE ENTRY AT CULVERT FROM
											SURF RO AT FILL ONLY
12	5%	100	100	GRASS	RILLS	100'	15'	CROWN OUT	Y		SEEDS & CULVERTS
Total											

RO = RECESS. OUTWASH
IC = ICE CONTACT

bb-3. Road Erosion Worksheet TOLT WATERSHED

Segment: F55 and F50

asin: Lower N.Fork/Yellow Cr.

Segment Length: 19000

) ad ent/ e	(2) Road Age yrs	(3) Rock Type	(4) Basic Erosion Rate-EB	CUTSLOPE (5) Value EC EB*0.40	(6) % Veg	(7) Veg Factor	ECe + (8) ECe	FILLSLOPE (9) Value EF EB*0.20	(10) % Veg	(11) Veg Factor	EFe + (12) EFe	DITCH (13) Value ED EB*0.05	(14) Armor Y/N	(15) Armor Factor	EDe + (16) EDe
1	>3	Till	60	24.0	No cut	0	0.0	12.0	0.37	0.18	2.2	3.0	---	0	0.0
2	>3	Kame	60	24.0	No cut	0	0.0	12.0	100	0.18	2.2	3.0	Y	0.95	2.9
3	>3	Undif drift	60	24.0	100	0.18	4.3	12.0	0/--	0.08	1.0	3.0	Y	0.95	2.9
4	>3	Vol/sed rx	30	12.0	100	0.18	2.2	6.0	60	0.37	2.2	1.5	---	0	0.0
5	>3	Reces outwsh	50	20.0	50/5	0.07	1.4	10.0	95	0.18	1.8	2.5	Y	0.95	2.4
				0.0			0.0	0.0			0.0	0.0			0.0
				0.0			0.0	0.0			0.0	0.0			0.0
				0.0			0.0	0.0			0.0	0.0			0.0

(ETe x Use = ETec) = ERe x ERd = ER

	SURFACING (17) Value ET EB*0.35	(18) Surface Factor	(19) ETe	TRAFFIC (20) Road Use	(21) Use Factor	(22) ETec	(23) ERe	DELIVERY (24) Buffer Factor N = 0	(25) Direct Entry %/100	(26) ERd	(27) Overall ER Rate t/ac/yr	(28) Hazard Rating H/M/L
1	21.0	0.2	4.2	H	50	210.0	212	0	0.7	0.7	149	M
2	21.0	0.2	4.2	H	50	210.0	215	0.1	0	0.1	22	L
3	21.0	0.2	4.2	H	50	210.0	218	0	1	1.0	218	H
4	10.5	0.2	2.1	H	50	105.0	109	0	1	1.0	109	M
5	17.5	0.2	3.5	H	50	175.0	181	0.8	0	0.8	144	M
	0.0		0.0			0.0	0			0.0	0	
	0.0		0.0			0.0	0			0.0	0	
	0.0		0.0			0.0	0			0.0	0	
								Total Segment ER =			11	L

GAMING (29) ER Heavy Traffic	(30) ER Light Traffic	(31) Segment Length ft	(32) Road Prism Width/ft	(33) Road Prism Acres	(34) Road Sediment tons/yr
149	16	200	30	0.1	20
22	3	300	30	0.2	4
218	29	400	30	0.3	60
109	15	115	30	0.1	9
144	18	500	35	0.4	58
0	0			0.0	0
0	0			0.0	0
0	0			0.0	0
Total sediment from segment					152

#3 OUTSLOPED ON CROWNED BUT OUTSLOPE SIDE BERMED

#5 – same?

Form 1. Road Segments Paralleling Streams Within 200 Ft.

WAU Tolt Segment Type 6 H Seg Map Number F55 + F50
26N 8E sections 29,20,21

Road Position TILL PLAIN Use MAINLINE - H Parent Material GLACIAL - VOL/SED RX

Road Characteristics										Area		Drainage			
Map Point	Surface Type	Surf. Depth	Cutslope-Veg %	Fillslope-Veg %	Ditch	Road Age	Rutting or Gullying?	Length	Width	Configuration	Direct Entry?	Pathway	How Far?	Stream Type	Comments
1	C.R.	6"	—	70%	no		very slight	200'	15'	Crown	no	fillslope	10 ft.		4% slope east to west; SEE REVERSE
2	0.5	6"	—	100%	north side only		slight	300'	15'	Crown	no	forest floor	75 ft.-100 ft		south side of rd no ditch-bermed; rd. 75'-100' from center; 3% slope
3	0.5	6"	100%	see comment Ø%	(rock armor) " "		slight to moderate	400'	15'	Crown to outslope	yes	ditch	ditch flows into		replaced original culvert with larger one; fillslope around culvert only fillslope area - appx 10 ft. length see reverse →
4	0.5	6"	100%	60%	no		slight	115'	15'	outslope	yes	road surface	5 ft. from rd. surf. to water		2 culverts spaced 10 ft. apart west culvert very minimal amt. of water; 4% slope (west to east)
5	0.5	6"	50% - 100' length only cutslope area	95%	rock Armor		very slight	500'	20'	outslope	no	fillslope	10-18 ft		6% slope rd. way either side of creek - no ditch south side - some segments bermed
Total															

#1 gravel berm from road grading present along both sides of rd.

Original wetland area appears to have been drained (?) / receded to the point of small creek flowing thru - unable to locate culvert - apparently water submerging + resurfacing on other side of rdwy.

old culverts found (shotgun style) now located approx. 50 ft. away from current water source (to the west) emptied into severely gullied stream bed (now dry).

MAY FLOW SEASONALLY TO A CLOSED DEPRESSION

#3 entire south edge of rd. is bermed w/ rd. surfacing material - 0% slope

rm bb-3. Road Erosion Worksheet TOLT WATERSHED
ad Segment: Mainline 80 from T70 to Dry Cr
b-basin: Lower S.Fork and Upper N. Fork
tal Segment Length(ft): 30400

ECe + EFe + EDe +

				CUTSLOPE				FILLSLOPE				DITCH			
(1) Road gment/ Site	(2) Road Age yrs	(3) Rock Type	(4) Basic Erosion Rate-EB	(5) Value EC EB*0.40	(6) % Veg	(7) Veg Factor	(8) ECe	(9) Value EF EB*0.20	(10) % Veg	(11) Veg Factor	(12) EFe	(13) Value ED EB*0.05	(14) Armor Y/N	(15) Armor Factor	(16) EDe
1	>3	Reces outwsh	50	20.0	---	0	0.0	10.0	50	0.37	3.7	2.5	?	1	2.5
2	>3	Alluvial fan	50	20.0	---	0	0.0	10.0	50	0.37	3.7	2.5	?	1	2.5
3	>3	Reces outwsh	50	20.0	---	0	0.0	10.0	100	0.18	1.8	2.5	Y	0.95	2.4
4	>3	Reces outwsh	50	20.0	---	0	0.0	10.0	50	0.37	3.7	2.5	N	1	2.5
5	>3	Reces outwsh	50	20.0	100	0.18	3.6	10.0	100	0.18	1.8	2.5	Y	0.95	2.4
6	>3	Reces outwsh	50	20.0	80	0.18	3.6	10.0	100	0.18	1.8	2.5	Y	0.95	2.4
7	>3	Reces outwsh	50	20.0	---	0	0.0	10.0	25	0.63	6.3	2.5	?	1	2.5
8	>3	Reces outwsh	50	20.0	10	0.77	15.4	10.0	25	0.63	6.3	2.5	---	0	0.0

(ETe x Use = ETec) = ERe x ERd = ER

	SURFACING			TRAFFIC				DELIVERY				
	(17) Value ET EB*0.35	(18) Surface Factor	(19) ETe	(20) Road Use	(21) Use Factor	(22) ETec	(23) ERe	(24) Buffer Factor N = 0	(25) Direct Entry %/100	(26) ERd	(27) Overall ER Rate t/ac/yr	(28) Hazard Rating H/M/L
1	17.5	0.2	3.5	H	50	175.0	181	0	1	1.0	181	H
2	17.5	0.2	3.5	H	50	175.0	181	0	1	1.0	181	H
3	17.5	0.2	3.5	H	50	175.0	179	0	1	1.0	179	H
4	17.5	0.2	3.5	H	50	175.0	181	0	1	1.0	181	H
5	17.5	0.2	3.5	H	50	175.0	183	0	1	1.0	183	H
6	17.5	0.2	3.5	H	50	175.0	183	0	1	1.0	183	H
7	17.5	0.2	3.5	H	50	175.0	184	0	1	1.0	184	H
8	17.5	0.2	3.5	H	50	175.0	197	0	1	1.0	197	H
								Total Segment ER =			20	L

GAMING					
(29) ER Heavy Traffic	(30) ER Light Traffic	(31) Segment Length ft	(32) Road Prism Width/ft	(33) Road Prism Acres	(34) Road Sediment tons/yr
181	24	1000	25	0.6	104
181	24	300	25	0.2	31
179	22	300	25	0.2	31
181	24	250	25	0.1	26
183	25	800	30	0.6	101
183	25	400	35	0.3	59
184	26	200	30	0.1	25
197	39	100	25	0.1	11
Total sediment from segment					388

1-5 — Long length
of road
draining
to stream

6-8

2-26-93

Form 1. Road Segments Paralleling Streams Within 200 Ft.

WAU: Tolt — Till Plain
Segment Type: 6H
Seg Map Number: Mainline (from Rt. 60 - to Dry Creek) 26N-8E + 26N-9E
Road Position: Toe Slope - Alluvial Plain
Use: Mainline - Heavy Truck
Parent Material: Ro = Recessional Outwash; Alluvial Fan Deposit

Map Point	Surface Type	Surf. Depth	Cutslope-Veg %	Fillslope-Veg %	Ditch	Road Age	Rutting or Gullying?	Length	Width - Road	Configuration	Direct Entry?	Pathway	How Far?	Stream Type	Comments
1	O.S.	6"	/	50%	?. snow E side only	73	very slight	1000 ft	18'	west slope into creek	yes	rd. surf	4 ft.		2-3% slope; snow; fillslope veg. gone due to snow
2	O.S.			50%	? snow		slight	300 ft	15'	east slope into creek	yes	rd surface	5 ft.		Snow; concrete bridge; direct entry occuring 30 ft. N of bridge where →
3	O.S.		/	100%	rock & veg.		no	300 ft.	15'	west slope	yes	east side ditch			direct entry occuring from direct entry occur... unable to determine if any
4	O.S.		/	50%	rock armor		no	250 ft.	15'	crowned	yes	ditch			creek bed dry at this time but ditch has signs of high erosion + gullying (east side)
5	O.S.		100%	100%	rock armor		slight	800 ft	15'	inslope (east)	yes	rd. surface	1-2 ft.		running water in ditch beginning at turn in rd. flowing down into river; 4% slope; →
6	O.S	6"	80%	100%	rock & veg.		no	400 ft	24'	outsloped (east)	yes	ditch			5% slope to the N of stream crossing; direct entry occuring on W side - * erosion of river bank -
7	O.S.		/	25%	?. snow		slight.	200'	24'	outsloped (east)	?*				* unknown due to snow + road material berm created when road cleared of snow →
8	O.S.		10%	25%	Ø	✓	slight	100'	15'	slight outslope (east)					cutslope failure - bank undercutting from loss of support (W side of rd) →
Total															

Mary -

You will notice some crossings on the map that were not written up - this was due to too much snow.

Regarding 26N 9E #8 - this whole stretch of area had problems with slides. Steve is quite familiar with the area and can provide further information.

Thank you + continued good luck with this project,
Julie

bH

rm bb-3. Road Erosion Worksheet TOLT WATERSHED
ad Segment: Mainline 60 road
b-basin: Lower S. Fork
tal Segment Length: 20500

				ECe + CUTSLOPE				EFe + FILLSLOPE				EDe + DITCH			
(1) Road gment/ Site	(2) Road Age yrs	(3) Rock Type	(4) Basic Erosion Rate-EB	(5) Value EC EB*0.40	(6) % Veg	(7) Veg Factor	(8) ECe	(9) Value EF EB*0.20	(10) % Veg	(11) Veg Factor	(12) EFe	(13) Value ED EB*0.05	(14) Armor Y/N	(15) Armor Factor	(16) EDe
1	>3	Reces outwsh	50	20.0	no cut	0	0.0	10.0	100	0.18	1.8	2.5	Y	0.95	2.4
2	>3	Reces outwsh	50	20.0	no cut	0	0.0	10.0	90	0.18	1.8	2.5	Y	0.95	2.4
3	>3	Reces outwsh	50	20.0	no cut	0	0.0	10.0	85	0.18	1.8	2.5	Y	0.95	2.4
				0.0			0.0	0.0			0.0	0.0			0.0
				0.0			0.0	0.0			0.0	0.0			0.0
				0.0			0.0	0.0			0.0	0.0			0.0
				0.0			0.0	0.0			0.0	0.0			0.0
				0.0			0.0	0.0			0.0	0.0			0.0

(ETe x Use = ETec) = ERe x ERd = ER

SURFACING			TRAFFIC				DELIVERY				
(17) Value ET EB*0.35	(18) Surface Factor	(19) ETe	(20) Road Use	(21) Use Factor	(22) ETec	(23) ERe	(24) Buffer Factor N = 0	(25) Direct Entry %/100	(26) ERd	(27) Overall ER Rate t/ac/yr	(28) Hazard Rating H/M/L
17.5	0.2	3.5	H	50	175.0	179	0	1	1.0	179	H
17.5	0.2	3.5	H	50	175.0	179	0.05	0.6	0.6	111	M
17.5	0.2	3.5	H	50	175.0	179	0.8	0	0.8	143	M
0.0		0.0			0.0	0			0.0	0	
0.0		0.0			0.0	0			0.0	0	
0.0		0.0			0.0	0			0.0	0	
0.0		0.0			0.0	0			0.0	0	
0.0		0.0			0.0	0			0.0	0	
							Total Segment ER =			21	L

GAMING					
(29) ER Heavy Traffic	(30) ER Light Traffic	(31) Segment Length ft	(32) Road Prism Width/ft	(33) Road Prism Acres	(34) Road Sediment tons/yr
179	22	450	30	0.3	56
111	13	350	30	0.2	27
143	17	2100	30	1.4	207
0	0			0.0	0
0	0			0.0	0
0	0			0.0	0
0	0			0.0	0
0	0			0.0	0
Total sediment from segment					290

20,500 ft - map wheel

Form 1. Road Segments Paralleling Streams Within 200 Ft.

WAU: Tolt   Segment Type: 6H   Seg Map Number: Rd 60 Mainline 26N 8E Sect.- 23, 26, 35, 36

Road Position: Till Plain   Use: H   Parent Material: Recessional outwash - some gravel dominated

Map Point	Surface Type	Surf. Depth	Cutslope-Veg %	Fillslope-Veg %	Ditch	Road Age	Rutting or Gullying?	Length	Width	Configuration	Direct Entry?	Pathway	How Far?	Stream Type	Comments
	Road Characteristics							Area			Drainage				
1	O.S.	6"	/	100%	VEG.		moderate	450ft	20ft	crown	yes	ditch			Concrete bridge; 0-4% (south side bridge 4%) N. Fork Tolt; see reverse →
2	O.S.	6"	/	90%	rock armor		slight	350 ft.	15'	crown	yes	ditch & rd. surface	10 ft		N side of rd direct entry into creek - approx. 75' long channel created from end of ditch to creek
3	O.S	6"	/	85%	rock armor		slight	2100 ft	15'	crown	no				Old piece of culvert - appears same size as culvert in use now - in good shape
Total															

6 L

orm bb-3. Road Erosion Worksheet TOLT WATERSHED

oad Segment: 60 Rd 26N8E S23

ub-basin: Yellow Cr

otal Segment Length: 9500

				CUTSLOPE			ECe +	FILLSLOPE			EFe +	DITCH			EDe +
(1) Road egment/ Site	(2) Road Age yrs	(3) Rock Type	(4) Basic Erosion Rate-EB	(5) Value EC EB*0.40	(6) % Veg	(7) Veg Factor	(8) ECe	(9) Value EF EB*0.20	(10) % Veg	(11) Veg Factor	(12) EFe	(13) Value ED EB*0.05	(14) Armor Y/N	(15) Armor Factor	(16) EDe
1	>3	Reces outwsh	50	20.0	75	0.37	7.4	10.0	80	0.18	1.8	2.5	Y	0.95	2.4
2	>3	Reces outwsh	50	20.0	100	0.18	3.6	10.0	80	0.18	1.8	2.5	Y	0.95	2.4
3	>3	Reces outwsh	50	20.0	100	0.18	3.6	10.0	80	0.18	1.8	2.5	Y	0.95	2.4
4	>3	Till/vol rx	40	16.0	50	0.37	5.9	8.0	80	0.18	1.4	2.0	N	1	2.0
				0.0			0.0	0.0			0.0	0.0			0.0
				0.0			0.0	0.0			0.0	0.0			0.0
				0.0			0.0	0.0			0.0	0.0			0.0
				0.0			0.0	0.0			0.0	0.0			0.0

(ETe x Use = ETec) = ERe x ERd = ER

	SURFACING			TRAFFIC				DELIVERY				
	(17) Value ET EB*0.35	(18) Surface Factor	(19) ETe	(20) Road Use	(21) Use Factor	(22) ETec	(23) ERe	(24) Buffer Factor N = 0	(25) Direct Entry %/100	(26) ERd	(27) Overall ER Rate t/ac/yr	(28) Hazard Rating H/M/L
1	17.5	0.2	3.5	L	5	17.5	29	0	1	1.0	29	L
2	17.5	0.2	3.5	L	5	17.5	25	0	1	1.0	25	L
3	17.5	0.2	3.5	L	5	17.5	25	0	1	1.0	25	L
4	14.0	0.2	2.8	L	5	14.0	23	0	0	0.0	0	L
	0.0		0.0			0.0	0			0.0	0	
	0.0		0.0			0.0	0			0.0	0	
	0.0		0.0			0.0	0			0.0	0	
	0.0		0.0			0.0	0			0.0	0	
								Total Segment ER =			2	L

GAMING					
(29) ER Heavy Traffic	(30) ER Light Traffic	(31) Segment Length ft	(32) Road Prism Width/ft	(33) Road Prism Acres	(34) Road Sediment tons/yr
187	29	75	35	0.1	2
183	25	400	35	0.3	8
183	25	400	35	0.3	8
0	0	2100	30	1.4	0
0	0			0.0	0
0	0			0.0	0
0	0			0.0	0
0	0			0.0	0
Total sediment from segment					18

SU WEO
1.8 MILE

Form 1. Road Segments Paralleling Streams Within 200 Ft.

WAU TOLT Segment Type 6L Seg Map Number 60 STARTS 26N8 SEC 2

Road Position TOE TO RIDGE Use LIGHT TRUCK Parent Material GLACIAL OUTWASH, TILL + LIMITED EXP of VOL/SED ROCK

Map Point	Surface Type	Surf. Depth	Cutslope-Veg %	Fillslope-Veg %	Ditch	Road Age YRS	Rutting or Gullying?	Length	Width	Configuration	Direct Entry?	Pathway	How Far?	Stream Type	Comments
	Road Characteristics								Area		Drainage				
1	G	76"	75%	80+	A	73	SLIGHT	75'	15'	CROWN	Y	FILL	15'	5	7% GRADE - STREAM DISSIPATES BE... ON BENC...
2		76	100	80+	OUT BERM	73	SLIGHT WASHBD	400'	15'	OUT	Y	FILL	3'	5	XING - SURF. RO... ERODING NEXT TO CULVERT 12% GR...
3		6"	100	80+	OUT BERM	73	SLIGHT	400'	15'	OUT	Y	FILL	3'	5	XING 12% GRADE
4		76"	50+	80+	E	73	Y	2100	15	LEV. OR CROWN	N				MI 1.8 - BLOW DOWN; UPPER PORTION RECENTLY GRAVELED & BLADED; 2'+ OUTSIDE BERM - INBOARD DITCH ERODING - CARRYING SED. + H2O - FINES ONLY, 2 X DRAINS IN 0.4 1 DOESN'T FUNCTION RILLING INBOARD OF BERM
THIS STREAM GOES SUB-SURFACE BELOW COUNTY BEACH ABOVE N. FORK TOLT															
Total															

SEC. OUTWASH

TILL OVER VOL/SED RX

XING -

G = GRAVEL
A = ARMOR
E = ...

6 H

Form bb-3. Road Erosion Worksheet TOLT WATERSHED

Road Segment: T70 mainline rd to reservoir

Sub-basin: Lower S. Fork

Total Segment Length: 7400

ECe + EFe + EDe +

				CUTSLOPE				FILLSLOPE				DITCH			
(1) Road Segment/ Site	(2) Road Age yrs	(3) Rock Type	(4) Basic Erosion Rate-EB	(5) Value EC EB*0.40	(6) % Veg	(7) Veg Factor	(8) ECe	(9) Value EF EB*0.20	(10) % Veg	(11) Veg Factor	(12) EFe	(13) Value ED EB*0.05	(14) Armor Y/N	(15) Armor Factor	(16) EDe
1	>3	Moraine	50	20.0	80	0.18	3.6	10.0	-0-	0	0.0	2.5	N	1	2.5
				0.0			0.0	0.0			0.0	0.0			0.0
				0.0			0.0	0.0			0.0	0.0			0.0
				0.0			0.0	0.0			0.0	0.0			0.0
				0.0			0.0	0.0			0.0	0.0			0.0
				0.0			0.0	0.0			0.0	0.0			0.0
				0.0			0.0	0.0			0.0	0.0			0.0
				0.0			0.0	0.0			0.0	0.0			0.0

(ETe x Use = ETec) = ERe x ERd = ER

	SURFACING			TRAFFIC				DELIVERY				
	(17) Value ET EB*0.35	(18) Surface Factor	(19) ETe	(20) Road Use	(21) Use Factor	(22) ETec	(23) ERe	(24) Buffer Factor N = 0	(25) Direct Entry %/100	(26) ERd	(27) Overall ER Rate t/ac/yr	(28) Hazard Rating H/M/L
1	17.5	0.2	3.5	H	50	175.0	181	0.1	?	0.1	18	L
	0.0		0.0			0.0	0			0.0	0	
	0.0		0.0			0.0	0			0.0	0	
	0.0		0.0			0.0	0			0.0	0	
	0.0		0.0			0.0	0			0.0	0	
	0.0		0.0			0.0	0			0.0	0	
	0.0		0.0			0.0	0			0.0	0	
	0.0		0.0			0.0	0			0.0	0	
								Total Segment ER =			2	L

GAMING					
(29) ER Heavy Traffic	(30) ER Light Traffic	(31) Segment Length ft	(32) Road Prism Width/ft	(33) Road Prism Acres	(34) Road Sediment tons/yr
18	2	1000	20	0.5	8
0	0			0.0	0
0	0			0.0	0
0	0			0.0	0
0	0			0.0	0
0	0			0.0	0
0	0			0.0	0
0	0			0.0	0
Total sediment from segment					8

2 · 9-93

Form 1. Road Segments Paralleling Streams Within 200 Ft.

WAU Tolt S. Fork Segment Type 6H Seg Map Number T70 – Road to Reservoir

Road Position Bench Use 6H Parent Material Moraine 1.4 mi

Road Characteristics								Area			Drainage				
Map Point	Surface Type	Surf. Depth	Cutslope-Veg %	Fillslope-Veg %	Ditch	Road Age	Rutting or Gullying?	Length	Width	Configuration	Direct Entry?	Pathway	How Far?	Stream Type	Comments
	Rb	6"+	80+	80+	Erod	>3	Yes	1.4 mi	20'	CR	N	—	—	—	Long Gradient
															Eroding in Board
															Ditch – No Relief
															Bladed Berm –
															Rilling Outboard of
															Tread – Water
															Runs Down & Creat[illegible]
															Small Gullies on
															Spur Road
1	1.														Ditch Eroding at [illegible]
1	Rb	6"+	/	/	Grass + Eroding	>3	Gullies				?	—	—	—	Right Road Edge
															Eroding – Direct
															Entry Uncertain.
															Road Segs. Direct [illegible]
															Ditch That may
															Drain onto Bench
															Above River or to
															Small Stream.
Total															

6L

Form bb-3. Road Erosion Worksheet TOLT WATERSHED

Road Segment: 90 Rd 26N9E SE1/4 7

Sub-basin: Upper N. Fork

Total Segment Length(ft): 3200

				ECe +				EFe +				EDe +			
				CUTSLOPE				FILLSLOPE				DITCH			
(1) Road Segment/ Site	(2) Road Age yrs	(3) Rock Type	(4) Basic Erosion Rate-EB	(5) Value EC EB*0.40	(6) % Veg	(7) Veg Factor	(8) ECe	(9) Value EF EB*0.20	(10) % Veg	(11) Veg Factor	(12) EFe	(13) Value ED EB*0.05	(14) Armor Y/N	(15) Armor Factor	(16) EDe
1	>3	Reces outwsh	50	20.0	-0-	0	0.0	10.0	50	0.37	3.7	2.5	Y	0.95	2.4
2	>3	Alluvial fan	50	20.0	100	0.18	3.6	10.0	50	0.37	3.7	2.5	Y	0.95	2.4
				0.0			0.0	0.0			0.0	0.0			0.0
				0.0			0.0	0.0			0.0	0.0			0.0
				0.0			0.0	0.0			0.0	0.0			0.0
				0.0			0.0	0.0			0.0	0.0			0.0
				0.0			0.0	0.0			0.0	0.0			0.0
				0.0			0.0	0.0			0.0	0.0			0.0

(ETe x Use = ETec) = ERe x ERd = ER

	SURFACING			TRAFFIC				DELIVERY				
	(17) Value ET EB*0.35	(18) Surface Factor	(19) ETe	(20) Road Use	(21) Use Factor	(22) ETec	(23) ERe	(24) Buffer Factor N = 0	(25) Direct Entry %/100	(26) ERd	(27) Overall ER Rate t/ac/yr	(28) Hazard Rating H/M/L
1	17.5	0.2	3.5	L	5	17.5	24	0	1	1.0	24	L
2	17.5	0.2	3.5	L	5	17.5	27	0	1	1.0	27	L
	0.0		0.0			0.0	0			0.0	0	
	0.0		0.0			0.0	0			0.0	0	
	0.0		0.0			0.0	0			0.0	0	
	0.0		0.0			0.0	0			0.0	0	
	0.0		0.0			0.0	0			0.0	0	
	0.0		0.0			0.0	0			0.0	0	
								Total Segment ER =			3	L

GAMING					
(29) ER Heavy Traffic	(30) ER Light Traffic	(31) Segment Length ft	(32) Road Prism Width/ft	(33) Road Prism Acres	(34) Road Sediment tons/yr
181	24	250	25	0.1	3
185	27	100	30	0.1	2
0	0			0.0	0
0	0			0.0	0
0	0			0.0	0
0	0			0.0	0
0	0			0.0	0
0	0			0.0	0
Total sediment from segment					5

6

Form bb-3. Road Erosion Worksheet TOLT WATERSHED

Road Segment: 90 Rd 26N9E SE1/4 7

Sub-basin: Upper N. Fork

Total Segment Length(ft): 1400

				CUTSLOPE			ECe +	FILLSLOPE			EFe +	DITCH			EDe +
(1) Road Segment/ Site	(2) Road Age yrs	(3) Rock Type	(4) Basic Erosion Rate-EB	(5) Value EC EB*0.40	(6) % Veg	(7) Veg Factor	(8) ECe	(9) Value EF EB*0.20	(10) % Veg	(11) Veg Factor	(12) EFe	(13) Value ED EB*0.05	(14) Armor Y/N	(15) Armor Factor	(16) EDe
3	>3	Reces outwsh	50	20.0	50	0.37	7.4	10.0	75	0.37	3.7	2.5	Y	0.95	2.4
4	>3	Reces outwsh	50	20.0	65	0.37	7.4	10.0	20	0.63	6.3	2.5	Y	0.95	2.4
				0.0			0.0	0.0			0.0	0.0			0.0
				0.0			0.0	0.0			0.0	0.0			0.0
				0.0			0.0	0.0			0.0	0.0			0.0
				0.0			0.0	0.0			0.0	0.0			0.0
				0.0			0.0	0.0			0.0	0.0			0.0
				0.0			0.0	0.0			0.0	0.0			0.0

(ETe x Use = ETec) = ERe x ERd = ER

	SURFACING			TRAFFIC				DELIVERY				
	(17) Value ET EB*0.35	(18) Surface Factor	(19) ETe	(20) Road Use	(21) Use Factor	(22) ETec	(23) ERe	(24) Buffer Factor N = 0	(25) Direct Entry %/100	(26) ERd	(27) Overall ER Rate t/ac/yr	(28) Hazard Rating H/M/L
3	17.5	0.2	3.5	G	1	3.5	17	0	1	1.0	17	L
4	17.5	0.2	3.5	G	1	3.5	20	0	1	1.0	20	L
	0.0		0.0			0.0	0			0.0	0	
	0.0		0.0			0.0	0			0.0	0	
	0.0		0.0			0.0	0			0.0	0	
	0.0		0.0			0.0	0			0.0	0	
	0.0		0.0			0.0	0			0.0	0	
	0.0		0.0			0.0	0			0.0	0	
							Total Segment ER =				9	L

GAMING					
(29) ER Heavy Traffic	(30) ER Light Traffic	(31) Segment Length ft	(32) Road Prism Width/ft	(33) Road Prism Acres	(34) Road Sediment tons/yr
188	31	300	30	0.2	4
191	34	400	30	0.3	5
0	0			0.0	0
0	0			0.0	0
0	0			0.0	0
0	0			0.0	0
0	0			0.0	0
0	0			0.0	0
Total sediment from segment					9

6L [illegible]
6G 1400 ft [illegible] SEGMENTS BY [illegible] USE.

Form 1. Road Segments Paralleling Streams Within 200 Ft.

WAU TOLT Segment Type ↓ Seg Map Number Rd 90

26N 9E - SE¼ 7

Road Position ALLUVIAL PLAIN Use 6L - 6G Parent Material 1 - RECESS. OUTWASH
2 - ALLUVIAL FAN
3 - RECESS. OUTWASH
4 - RECESS. OUTWASH

	Road Characteristics										Area		Drainage			
	Map Point	Surface Type	Surf. Depth	Cutslope-Veg %	Fillslope-Veg %	Ditch	Road Age	Rutting or Gullying?	Length	Width	Configuration	Direct Entry?	Pathway	How Far?	Stream Type	Comments
6L	1	gravel O.S.	6"	/	50%	rock Armor		?-snow	250'	18'	sloped to the south	yes	ditch to rd. surf. above culvert	7ft.		direct entry occurring on S side of rd; 3-4% slope to the W of culvert.
6L	2	0.S	6"	100%	50% [illegible]	rock & veg		see comments	100'	15'	crowned	ASSUME DELIVERY				rd. beginning to fail - E side major loss - some sinkage entire portion; difficult to ascert. why rd. failing: loss of [illegible] slope →
6G	3	0.S.	6"	50%	75%	rock & soil		? - snow	300'	15'	outsloped + crowned	yes	ditch			6-7% slope
6G	4	0.S	6"	65%	20%	rock Armor		? - snow	400'	15'	crowned	yes	ditch, rd. surf.			rd completely washed out - old purge. flat at crossing. 6-6% slope W of crossing
	Total															

6L

Form bb-3. Road Erosion Worksheet TOLT WATERSHED

Road Segment: F20 Rd

Sub-basin: Lower S. Fork

Total Segment Length: 7200

				CUTSLOPE (ECe +)				FILLSLOPE (EFe +)				DITCH (EDe +)			
(1) Road Segment/ Site	(2) Road Age yrs	(3) Rock Type	(4) Basic Erosion Rate-EB	(5) Value EC EB*0.40	(6) % Veg	(7) Veg Factor	(8) ECe	(9) Value EF EB*0.20	(10) % Veg	(11) Veg Factor	(12) EFe	(13) Value ED EB*0.05	(14) Armor Y/N	(15) Armor Factor	(16) EDe
2	>3	Reces outwsh	50	20.0	100	0.18	3.6	10.0	20	0.63	6.3	2.5	Y	0.95	2.4
3	>3	Reces outwsh	50	20.0	-0-	0	0.0	10.0	30	0.53	5.3	2.5	-0-	0	0.0
				0.0			0.0	0.0			0.0	0.0			0.0
				0.0			0.0	0.0			0.0	0.0			0.0
				0.0			0.0	0.0			0.0	0.0			0.0
				0.0			0.0	0.0			0.0	0.0			0.0
				0.0			0.0	0.0			0.0	0.0			0.0
				0.0			0.0	0.0			0.0	0.0			0.0

(ETe x Use = ETec) = ERe x ERd = ER

	SURFACING			TRAFFIC				DELIVERY				
	(17) Value ET EB*0.35	(18) Surface Factor	(19) ETe	(20) Road Use	(21) Use Factor	(22) ETec	(23) ERe	(24) Buffer Factor N = 0	(25) Direct Entry %/100	(26) ERd	(27) Overall ER Rate t/ac/yr	(28) Hazard Rating H/M/L
2	17.5	0.2	3.5	L	5	17.5	30	0	0.8	0.8	24	L
3	17.5	0.2	3.5	L	5	17.5	23	0.1	0	0.1	2	L
	0.0		0.0			0.0	0			0.0	0	
	0.0		0.0			0.0	0			0.0	0	
	0.0		0.0			0.0	0			0.0	0	
	0.0		0.0			0.0	0			0.0	0	
	0.0		0.0			0.0	0			0.0	0	
	0.0		0.0			0.0	0			0.0	0	
								Total Segment ER =			1	L

GAMING					
(29) ER Heavy Traffic	(30) ER Light Traffic	(31) Segment Length ft	(32) Road Prism Width/ft	(33) Road Prism Acres	(34) Road Sediment tons/yr
150	24	175	20	0.1	2
18	2	125	15	0.0	0
0	0			0.0	0
0	0			0.0	0
0	0			0.0	0
0	0			0.0	0
0	0			0.0	0
0	0			0.0	0
Total sediment from segment					2

N - N

Form bb-3. Road Erosion Worksheet TOLT WATERSHED

Road Segment: F20 Rd abandoned portion to Lynch Lk

Sub-basin: Lower S. Fork

Total Segment Length: 2000

				CUTSLOPE (ECe +)				FILLSLOPE (EFe +)				DITCH (EDe +)			
(1) Road Segment/ Site	(2) Road Age yrs	(3) Rock Type	(4) Basic Erosion Rate-EB	(5) Value EC EB*0.40	(6) % Veg	(7) Veg Factor	(8) ECe	(9) Value EF EB*0.20	(10) % Veg	(11) Veg Factor	(12) EFe	(13) Value ED EB*0.05	(14) Armor Y/N	(15) Armor Factor	(16) EDe
1	>3	Reces outwsh	50	20.0	30	0.53	10.6	10.0	-0-	0	0.0	2.5	-0-	0	0.0
				0.0			0.0	0.0			0.0	0.0			0.0
				0.0			0.0	0.0			0.0	0.0			0.0
				0.0			0.0	0.0			0.0	0.0			0.0
				0.0			0.0	0.0			0.0	0.0			0.0
				0.0			0.0	0.0			0.0	0.0			0.0
				0.0			0.0	0.0			0.0	0.0			0.0
				0.0			0.0	0.0			0.0	0.0			0.0

(ETe x Use = ETec) = ERe x ERd = ER

	SURFACING			TRAFFIC				DELIVERY				
	(17) Value ET EB*0.35	(18) Surface Factor	(19) ETe	(20) Road Use	(21) Use Factor	(22) ETec	(23) ERe	(24) Buffer Factor N = 0	(25) Direct Entry %/100	(26) ERd	(27) Overall ER Rate t/ac/yr	(28) Hazard Rating H/M/L
1	17.5	1	17.5	N	0.1	1.8	12	0	1	1.0	12	L
	0.0		0.0			0.0	0			0.0	0	
	0.0		0.0			0.0	0			0.0	0	
	0.0		0.0			0.0	0			0.0	0	
	0.0		0.0			0.0	0			0.0	0	
	0.0		0.0			0.0	0			0.0	0	
	0.0		0.0			0.0	0			0.0	0	
	0.0		0.0			0.0	0			0.0	0	
							Total Segment ER =				9	L

GAMING					
(29) ER Heavy Traffic	(30) ER Light Traffic	(31) Segment Length ft	(32) Road Prism Width/ft	(33) Road Prism Acres	(34) Road Sediment tons/yr
886	98	1500	12	0.4	5
0	0			0.0	0
0	0			0.0	0
0	0			0.0	0
0	0			0.0	0
0	0			0.0	0
0	0			0.0	0
0	0			0.0	0
Total sediment from segment					5

Form 3. Road Segments With Erosion Indicators

MR

WAU: TOLT — LYNCH CREEK Seg Map Number: F20 Segment Type:

Road Position: BENCH Use: UPPER ABANDONED Indicator:

Surface Type: RG (RIVER GRAVEL) Surf. Depth: 6" Road Age: >34 YR Parent Material: OUTWASH & KAME DE…

1.3 MI

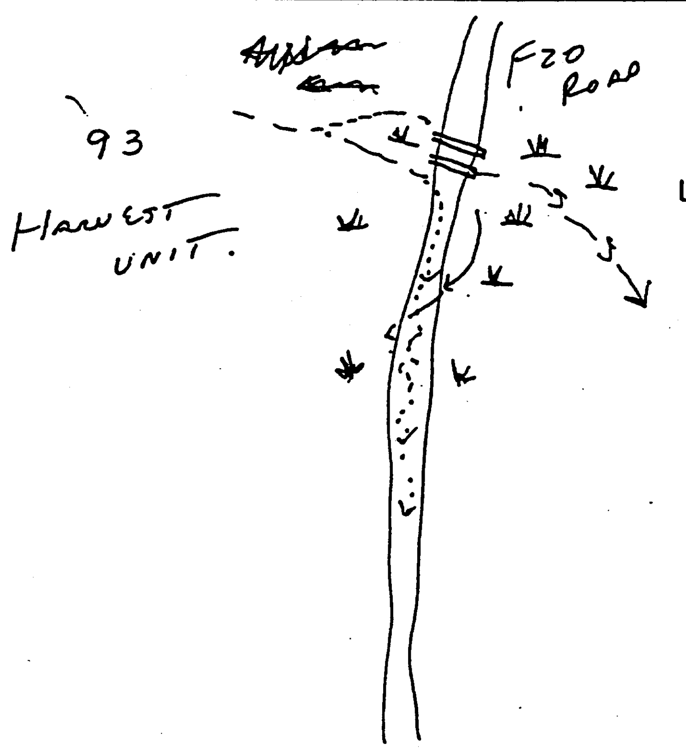
	ROAD GRADIENT %	Cutslope-Veg %	Fillslope-Veg %	Ditch	Rutting or Gullying of Ditch?	Length	Width	Configuration	Direct Entry?	Stream Type	Comments
1	0%	/	/	/	GULLIED	1500	12'	LEVEL	Y		STREAM DIVERTED DOWN RD
		↓	SEPARATE		INTO	2	ROAD	CATEGORIES	↑		SEE ATTACHED SHEET #1
2	0	/	10-20	/							SEE ATTACHED SHEET #2
3	0-2%	/	20-50	/	RILLS ON ROAD SURF.	125'	15'	LEVEL	N		ROAD PARALLELS STREAM W/IN 20-30' FOR 125' SLASH ON SLOPE & SEDIMENT GRADING BERM PRESENT MUCH SEDIMENT OCCURRING
Total											

Form 2. Road Segments Draining to Flowing Streams

Road Crossing Number F20-1 **Stream Type** ______

~~Soil Type~~ ______

Sketch the Road /Stream Configuration
(Include only portion directly draining to the stream)



SHOTGUN CULVERT UNDER RD UPSTREAM CULVERT ALMOST TOTALLY BLOCKED. WATER HAS FLOWED DOWN RD FOR ~1000-2000' - INTERMITTENTLY FLOWS IN AND OUT OF ROAD FROM DEPRESSION & WET AREA. XING WASHED OUT.

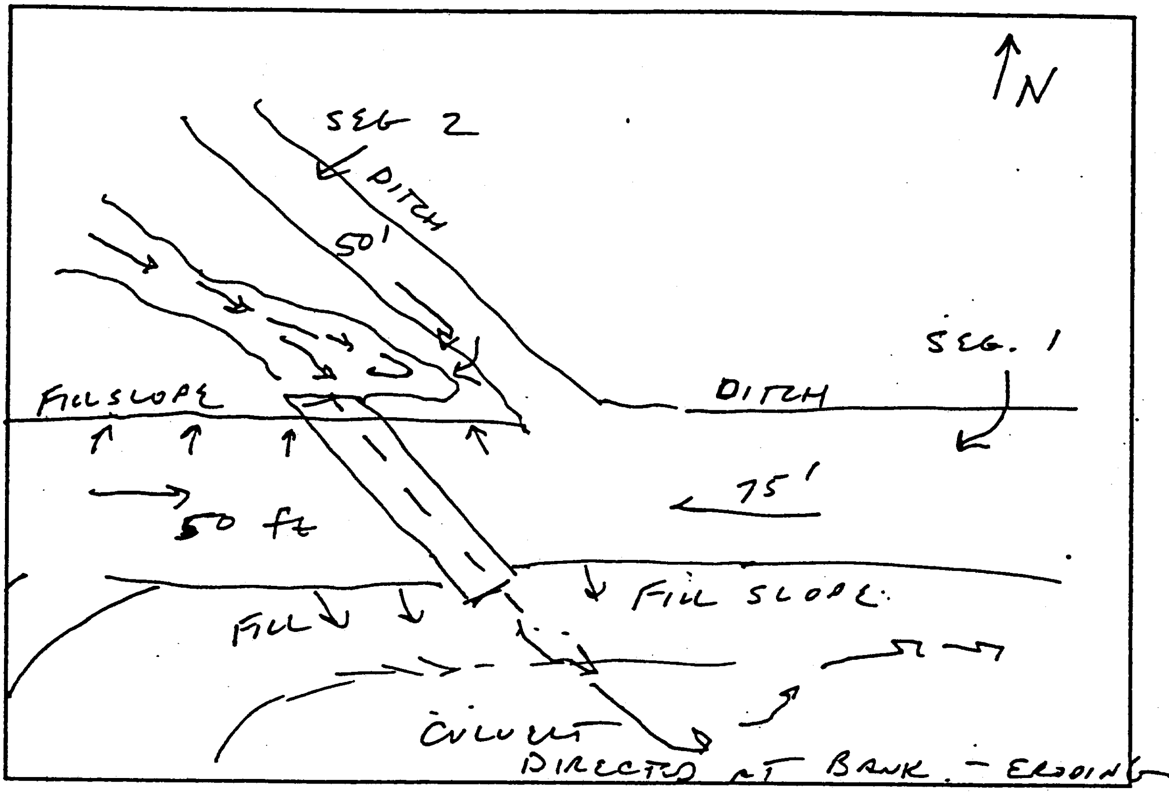
	Segment 1	Seg 2 (If needed)	Seg 3 (If needed)
Surfacing Type	RIVER GRAVEL		
Depth of Lift	0 - 2		
Cutslope Veg %	20 - 50		
Fillslope Veg %	NO FILLS		
Ditch Condition	NOT FUNCTIONING - IF THERE		
Road Age	73 YRS		
Length	~1500		
Width	12-15'		
Configuration	LEVEL - CONVEX		
Expected Use	ABANDONED		
Gradient	0 %		
COMMENTS	DUE TO PLUGGED CULVERT WATER STILL FLOWS DOWN RD AT PEAK FLOWS		
TOTAL SEDIMENT			

Form 2. Road Segments Draining to Flowing Streams

Road Crossing Number F20-2 **Stream Type** ______

Soil Type ______

Sketch the Road /Stream Configuration
(Include only portion directly draining to the stream)



	Segment 1	Seg 2 (If needed)	Seg 3 (If needed)
Surfacing Type	RIVER GRAVEL	RIVER GRAVEL	
Depth of Lift	TO 8' AT FILL	—	
Cutslope Veg %	NO CUTS	80 +	
Fillslope Veg %	LITTLE	20%	
Ditch Condition	SOME VEG	VEG	
Road Age	> 3 YRS.	> 3 YRS.	
Length	125'	50'	
Width	15'	12'	
Configuration	LEVEL OR CROWN	LEVEL OR OUT	
Expected Use	LIGHT TRUCK	GENERAL	
GRADIENT	0 - 1 %	3 - 5 %	
COMMENTS	FILL ACROSS		
	CREEK		
TOTAL SEDIMENT			

Form bb-3. Road Erosion Worksheet TOLT WATERSHED

Road Segment: 50 Road above dam

Sub-basin: South Fork above dam

Total Segment Length(ft): 11350

ECe + EFe + EDe +

				CUTSLOPE				FILLSLOPE				DITCH			
(1) Road Segment/ Site	(2) Road Age yrs	(3) Rock Type	(4) Basic Erosion Rate-EB	(5) Value EC EB*0.40	(6) % Veg	(7) Veg Factor	(8) ECe	(9) Value EF EB*0.20	(10) % Veg	(11) Veg Factor	(12) EFe	(13) Value ED EB*0.05	(14) Armor Y/N	(15) Armor Factor	(16) EDe
1	>3	Moraine	50	20.0	--	0	0.0	10.0	80	0.18	1.8	2.5	Y	0	0.0
2	>3	Moraine	50	20.0	70	0.37	7.4	10.0	100	0.18	1.8	2.5	Y	0.95	2.4
3	>3	Moraine	50	20.0	100	0.18	3.6	10.0	100	0.18	1.8	2.5	Y	0.95	2.4
4	>3	Alpine glacial	50	20.0	100	0.18	3.6	10.0	100	0.18	1.8	2.5	Y	0.95	2.4
5	>3	Alpine glacial	50	20.0	100	0.18	3.6	10.0	100	0.18	1.8	2.5	Y	0.95	2.4
6	>3	Alpine glacial	50	20.0	70	0.37	7.4	10.0	100	0.18	1.8	2.5	Y	0.95	2.4
7	>3	Alpine glacial	50	20.0	100	0.18	3.6	10.0	100	0.18	1.8	2.5	N	1	2.5
8	>3	Alpine glacial	50	20.0	100	0.18	3.6	10.0	100	0.18	1.8	2.5	Y	0.95	2.4
9	>3	Alpine glacial	50	20.0	100	0.18	3.6	10.0	100	0.18	1.8	2.5	Y	0.95	2.4
10	>3	Alpine glacial	50	20.0	100	0.18	3.6	10.0	100	0.18	1.8	2.5	Y	0.95	2.4
11	>3	Alpine glacial	50	20.0	70	0.37	7.4	10.0	100	0.18	1.8	2.5	N	1	2.5
12	>3	Alpine glacial	50	20.0	100	0.18	3.6	10.0	100	0.18	1.8	2.5	Y	0.95	2.4
13	>3	Alpine glacial	50	20.0	100	0.18	3.6	10.0	100	0.18	1.8	2.5	Y	0.95	2.4
14	>3	Alpine glacial	50	20.0	100	0.18	3.6	10.0	100	0.18	1.8	2.5	Y	0.95	2.4
15	>3	Alpine glacial	50	20.0	100	0.18	3.6	10.0	100	0.18	1.8	2.5	Y	0.95	2.4
16	>3	Alpine glacial	50	20.0	100	0.18	3.6	10.0	100	0.18	1.8	2.5	N	0.95	2.4
17	>3	Alpine glacial	50	20.0	100	0.18	3.6	10.0	100	0.18	1.8	2.5	Y	0.95	2.4

(ETe x Use = ETec) = ERe x ERd = ER

	SURFACING			TRAFFIC				DELIVERY					GAMING					
	(17) Value ET EB*0.35	(18) Surface Factor	(19) ETe	(20) Road Use	(21) Use Factor	(22) ETec	(23) ERe	(24) Buffer Factor N = 0	(25) Direct Entry %/100	(26) ERd	(27) Overall ER Rate t/ac/yr	(28) Hazard Rating H/M/L	(29) ER Heavy Traffic	(30) ER Light Traffic	(31) Segment Length ft	(32) Road Prism Width/ft	(33) Road Prism Acres	(34) Road Sediment tons/yr
1	17.5	0.2	3.5	G	1	3.5	5	0	1	1.0	5	L	177	19	225	40	0.2	1
2	17.5	0.2	3.5	G	1	3.5	15	0	1	1.0	15	L	187	29	500	30	0.3	5
3	17.5	0.2	3.5	G	1	3.5	11	0	1	1.0	11	L	183	25	470	30	0.3	4
4	17.5	0.2	3.5	G	1	3.5	11	0	1	1.0	11	L	183	25	150	30	0.1	1
5	17.5	0.2	3.5	G	1	3.5	11	0.15	0.65	0.7	8	L	128	18	400	30	0.3	2
6	17.5	0.2	3.5	G	1	3.5	15	0	1	1.0	15	L	187	29	350	30	0.2	4
7	17.5	0.2	3.5	G	1	3.5	11	1	0	1.0	11	L	183	25	30	30	0.0	0.2
8	17.5	0.2	3.5	G	1	3.5	11	0.2	1	1.0	11	L	183	25	300	35	0.2	3
9	17.5	0.2	3.5	G	1	3.5	11	0	1	1.0	11	L	183	25	100	35	0.1	0.9
10	17.5	0.2	3.5	G	1	3.5	11	0	1	1.0	11	L	183	25	100	30	0.1	0.8
11	17.5	0.2	3.5	G	1	3.5	15	0	1	1.0	15	L	187	29	350	35	0.3	4
12	17.5	0.2	3.5	G	1	3.5	11	0	1	1.0	11	L	183	25	200	30	0.1	2
13	17.5	0.2	3.5	G	1	3.5	11	0	1	1.0	11	L	183	25	100	30	0.1	0.8
14	17.5	0.2	3.5	G	1	3.5	11	0	1	1.0	11	L	183	25	300	30	0.2	2
15	17.5	0.2	3.5	G	1	3.5	11	0	1	1.0	11	L	183	25	500	30	0.3	4
16	17.5	0.2	3.5	G	1	3.5	11	0	1	1.0	11	L	183	25	300	35	0.2	3
17	17.5	0.2	3.5	G	1	3.5	11	0	1	1.0	11	L	183	25	25	35	0.0	0.2

(1) 3.22 ; MK MB

Form 1. Road Segments Paralleling Streams Within 200 Ft.

WAU Tolt Segment Type ______ Seg Map Number 50 Road above dam

Road Position Toe - Use 6G Parent Material Alluvium

Road Surface water is clear

Map Point	Surface Type	Surf. Depth	Cutslope-Veg %	Fillslope-Veg %	Ditch	Road Age	Rutting or Gullying?	Length	Width	Configuration	Direct Entry?	Pathway	How Far?	Stream Type	Comments
Road Characteristics										Area		Drainage			
1	PIT RUN	>6"	NOT CONTROL	100% EXCEPT SLUMP	ARM	>3	SLIGHT RILLS	225'	12'	OUT	Y	FILL			CONSULTANT CR. XING
															OVERFLOW CULVERT LOO-X[illegible]
															OUTBOARD FILL SLUMP [illegible]
?	Large inboard ditch - 1' culvert - not functioning - drains away from cons. cr. X'ing														
2	PIT R		70%	100%	Arm	>3	S Rill	500	12	OUT	yes	Fill Ditch			Collapsed [illegible] culvert - on-road within 10 [illegible]
3	PIT RUN		100	100	Arm	>3	slight rut	300	12	slight crown	yes	ditch fill		72	Spur drains to crossing
								200	10		N				Spur 72?
4	PIT	>6	100	100	Arm	>3	slight rut	150	12	S crown	Y	ditch			
5	PIT	>6	100	100	Arm	>3	S rut	250	12	OUT	Y	stream cross			Rainbow Ck ~~Excess~~ [illegible] water
								300	away from culvert is small debris - flow						
~~6~~	~~PIT~~														water on road
6	PIT	>6	70	100	Arm	>3	[illegible]	350	12	OUT	Y	ditch			a lot of W from 4 distinct sources, cutbank
7	PIT							200		OUT	NO				need for ditch to access creek
~~8~~	~~PIT~~							~~200~~							
8	PIT							350		level					Fill eroding into lake
9	PIT							100							culvert 1/2 in lake
Total															

(2)
See Sheet (1)

Form 1. Road Segments Paralleling Streams Within 200 Ft.

WAU ______ Segment Type ______ Seg Map Number ______

Road Position ______ Use 64 Parent Material ______

Map Point	Surface Type	Surf. Depth	Cutslope-Veg %	Fillslope-Veg %	Ditch	Road Age	Rutting or Gullying?	Length	Width	Configuration	Direct Entry?	Pathway	How Far?	Stream Type	Comments
	Road Characteristics								Area		Drainage				
10	PIT		100	100	Am	73	slight rut	100	10	level	Y	Dit fill			Ditch infiltrating culvert serving
11	PIT		70	100		''	''	300	10	OUT	Y				water from slide,
								'100	E -	water	over	road -			Ditch source? - no culvert
									total 350						outboard Fill eroding to
															Small debris flow in ditch
12	PIT		100	100	Am	''	''	200	10	OUT	Y	''	''		source of water
13	PIT		100	100	'	''	s Rut	100	12	Level	Y	Sha Ditch			small Stream Crossing
14	PIT		100	100	'	''	s Rut	200	''			CUL			Sediment Ponding
								100	'						Seasonal stream [illegible] contrib
15	DIT		100	100	'	''	s Rut	500	''	crown	Y	cul			
16	''		100	100	PART ARM	''	s Rut	300	''	crown	Y	cul			to Horseshoe CK. - Ditch
															eroding - small culverts opening
17	DIT							25	12	crown	Y	crossing			Log Puncheon - high
															Diversion pot. down road
Overall -	Sand/rock sliding on roads but clear water														2.15 miles - out of
		See reverse side													
Total															

18 — Just past Horseshoe, Road Gullies - No Delivery, Source unclear

[illegible] Road [illegible] down 10-12% Road rm bb-3. Road Erosion Worksheet TOLT WATERSHED

wland Road Surveys

				CUTSLOPE (ECc +)				FILLSLOPE (EFc +)				DITCH (EDe +)			
(1) Road gment/ Site	(2) Road Age yrs	(3) Rock Type	(4) Basic Erosion Rate-EB	(5) Value EC EB*0.40	(6) % Veg	(7) Veg Factor	(8) ECc	(9) Value EF EB*0.20	(10) % Veg	(11) Veg Factor	(12) EFc	(13) Value ED EB*0.05	(14) Armor Y/N	(15) Armor Factor	(16) EDe
2000 1000	>3	Till	60	24	100	0.18	4.32	12	-0-	0	0	3	Y	0.95	2.85
332 300	>3	Till	60	24	100	0.18	4.32	12	90	0.18	2.16	3	Y	0.95	2.85
				0			0	0			0	0			0
				0			0	0			0	0			0

(ETe x Use = ETec) = ERe x ERd = ER

SURFACING			TRAFFIC				DELIVERY				
(17) Value ET EB*0.35	(18) Surface Factor	(19) ETe	(20) Road Use	(21) Use Factor	(22) ETec	(23) ERe	(24) Buffer Factor N = 0	(25) Direct Entry %/100	(26) ERd	(27) Overall ER Rate t/ac/yr	(28) Hazard Rating H/M/L
21	0.2	4.2	L	5	21	28.17	0	0	0	0	L
21	0.2	4.2	G	1	4.2	13.53	0	0.02	0.02	0.27	L
0		0			0	0			0	0	
0		0			0	0			0	0	

GAMING	
(29) ER Heavy Traffic	(30) ER Light Traffic
0	0
4.3866	0.6066
0	0
0	0

2-16-93

STOSSEL CREEK **Form 3. Road Segments With Erosion Indicators**

WAU TOLT RIVER **Seg Map Number** ST 2000 ST 1000 26N 7E S1 **Segment Type** 6 L-H

Road Position RIDGE & SIDE SLOPE **Use** HEAVY-LIGHT TRAF. **Indicator** ______

Surface Type PIT RUN **Surf. Depth** >6" **Road Age** >3 YR **Parent Material** TILL

~2 MILES ROAD WITHIN WATERSHED ≈ 10,300 ft

ROAD GRADIENT %	Cutslope-Veg %	Fillslope-Veg %	Ditch	Rutting or Gullying of Ditch?	Length	Width	Configuration	Direct Entry?	Stream Type	Comments
0-10	100	/	VEG	NO		-	LEVEL OR CROWN	NO		MAINLY RIDGE ROAD
Total										

Form 3. Road Segments With Erosion Indicators

WAU Lower Tolt Seg Map Number #330 Segment Type 6G

Road Position Bench - Till plain Use Light general Indicator ____________

Surface Type 6" gravel Surf. Depth 6" Road Age 23 yrs Parent Material Till

ROAD GRADIENT %	Cutslope-Veg %	Fillslope-Veg %	Ditch	Rutting or Gullying of Ditch?	Length	Width	Configuration	Direct Entry?	Stream Type	Comments
3%	100	90	grass	no	150	10	mildly rutted level	yes	4 or 5	minor contributions
Total										

orm bb-3. Road Erosion Worksheet TOLT WATERSHED

owland Road Surveys

				CUTSLOPE			ECc +	FILLSLOPE			EFc +	DITCH			EDe +
(1) Road Segment/ Site	(2) Road Age yrs	(3) Rock Type	(4) Basic Erosion Rate-EB	(5) Value EC EB*0.40	(6) % Veg	(7) Veg Factor	(8) ECe	(9) Value EF EB*0.20	(10) % Veg	(11) Veg Factor	(12) EFe	(13) Value ED EB*0.05	(14) Armor Y/N	(15) Armor Factor	(16) EDe
G26N8E29	>3	Reces outwsh	50	20	90	0.18	3.6	10	90	0.18	1.8	2.5	N	1	2.5
on26827A	>3	Kame	50	20	90	0.18	3.6	10	90	0.18	1.8	2.5	N	1	2.5
170 non	>3	Reces outwsh	50	20	60	0.37	7.4	10	50	0.37	3.7	2.5	N	1	2.5
183 B	2	Reces outwsh	70	28	50	0.37	10.36	14	80	0.18	2.52	3.5	N	1	3.5

(ETe x Use = ETec) = ERe x ERd = ER

SURFACING			TRAFFIC				DELIVERY					GAMING	
(17) Value ET EB*0.35	(18) Surface Factor	(19) ETe	(20) Road Use	(21) Use Factor	(22) ETec	(23) ERe	(24) Buffer Factor N = 0	(25) Direct Entry %/100	(26) ERd	(27) Overall ER Rate t/ac/yr	(28) Hazard Rating H/M/L	(29) ER Heavy Traffic	(30) ER Light Traffic
17.5	0.2	3.5	G	1.8	6.3	14.2	0	0.05	0.05	0.71	L	9.145	1.27
17.5	0.2	3.5	N	0.1	0.35	8.25	0	0.05	0.05	0.41	L	9.145	1.27
17.5	0.2	3.5	N	0.1	0.35	13.95	0.5	0	0.5	6.98	L	94.3	15.55
24.5	0.2	4.9	G	1	4.9	21.28	0	0	0	0	L	0	0

-R-SEC

ROADS WORKSHEET B3 TOLT AREA 9

****

* ff = FIELD FORM B-2 COLUMN NUMBER

MAIN LINE

1	2	3	4	5	6	7	8
				CUTSLOPE			
ROAD SEGMENT (ff-2)*	ROAD AGE (ff-4)*	ROCK TYPE (ff-5)*	BASIC RATE TABLE B-5	VALUE (calc)	% VEG (ff-7)*	VEG FACTOR TABLE B-6	ECe (calc)
6H-26/8-A 30 29	>3	ALLUVIUM	50	20.00	90	0.18	3.60
6H-26/8-B 29-21-22-25	>3	ALLUVIUM	50	20.00	90	0.18	3.60
6H-26/8-C 26-35-36	>3	MOD WEATH	30	12.00	90	0.18	2.16
6H-26/9-B 31-30-	>3	MOD WEATH	30	12.00	90	0.18	2.16
~~6L-26/8-G~~ 27	>3	MOD WEATH	30	12.00	90	0.18	2.16
~~[illegible]~~	>3	MOD WEATH	30	12.00	90	0.18	2.16
~~6G26/829A~~	>3	MOD WEATH	REC OUTWASH 30	12.00	90	0.18	2.16
NON26827A	>3	MOD WEATH	Kam E 30	12.00	90	0.18	2.16

ROADS WORKSHEET B3 TOLT AREA 9

****

9	10	11	12	13	14	15	16
FILLSLOPE				DITCH			
VALUE (calc)	% VEG (ff-8)*	VEG FACTOR TABLE B-6	EFe (calc)	VALUE (calc)	ARMOURED (Y/N) (ff-10)*	ARMOUR FACTOR (text)	EDe (calc)
10.00	90	0.18	1.80	2.50	N	1.00	2.50
10.00	90	0.18	1.80	2.50	N	1.00	2.50
6.00	90	0.18	1.08	1.50	N	1.00	1.50
6.00	90	0.18	1.08	1.50	N	1.00	1.50
6.00	90	0.18	1.08	1.50	N	1.00	1.50
6.00	90	0.18	1.08	1.50	N	1.00	1.50
6.00	90	0.18	1.08	1.50	N	1.00	1.50
6.00	90	0.18	1.08	1.50	N	1.00	1.50

ROADS WORKSHEET B3 TOLT AREA 9
****

17	18	19	20	21	22	23	24
SURFACING/TRAFFIC							EROSION RATE
VALUE (calc)	ROAD TYPE (ff-3)*	SURFACE FACTOR TABLE B-7	ETe (calc)	ROAD USE (ff-3)*	USE FACTOR TABLE B-9	ETec (calc)	ERe (calc)
17.50	6H	0.20	3.50	H	36.10	126.35	134.25
17.50	6H	0.20	3.50	H	36.10	126.35	134.25
10.50	6H	0.20	2.10	H	36.10	75.81	80.55
10.50	6H	0.20	2.10	H	36.10	75.81	80.55
10.50	6L	0.20	2.10	L	7.50	15.75	20.49
10.50	6L	0.20	2.10	L	7.50	15.75	20.49
10.50	6L	0.20	2.10	G	1.80	3.78	8.52
10.50	6N	0.20	2.10	NON	0.10	0.21	4.95

ROADS WORKSHEET B3 TOLT AREA 9
****

LOW <10
MODERATE 10 - 20
HIGH >20

25	26	27	28	29	30	31	32	
DELIVERY								
ROAD OUTSLOPED (ff-9)	OUTSLOPE FACTOR (text)	OUTSLOPE ERe (calc)	% DIRECT ENTRY (ff-11)*	ERODBLTY ERd (calc)	BUFFER FACTOR (text)	OVERALL EROSION RATE	RATING H/M/L TABLE	FIELD CHECKED (Y/N)
Y	0.90	120.83	0.05	6.04	1.00	6.04	L	Y
Y	0.90	120.83	0.05	6.04	1.00	6.04	L	Y
Y	0.90	72.50	0.05	3.62	1.00	3.62	L	Y
Y	0.90	72.50	0.10	7.25	1.05	7.61	L	Y
Y	0.90	18.44	0.05	0.92	1.00	0.92	L	Y
Y	0.90	18.44	0.05	0.92	1.00	0.92	L	N
Y	0.90	7.67	0.05	0.38	1.00	0.38	L	Y
Y	0.90	4.46	0.05	0.22	1.00	0.22	L	Y

?

THIS IS FIELD FORM
WHY WASN'T THIS CHECKED?

Form 3. Road Segments With Erosion Indicators

WAU: TOLT Seg Map Number: 6170 Segment Type: LOWLAND NON-USE

Road Position: SLOPE TOE — ALLUVIAL PLAIN Use: NON-USE Indicator: ______

Surface Type: ______ Surf. Depth: ______ Road Age: <3 Parent Material: RECESSIONAL OUTWASH

ROAD GRADIENT %	Cutslope-Veg %	Fillslope-Veg %	Ditch	Rutting or Gullying of Ditch?	Length	Width	Configuration	Direct Entry?	Stream Type	Comments
ROAD PARALLELS STREAM W/IN 5 FEET IN SOME PLACES										
GARBAGE DUMPED INTO WETLAND FROM ROAD.										
ROAD ENTRANCE BLOCKED BY DITCH THAT ALSO										
TRAPS UPSLOPE DITCH SEDIMENT FROM ENTERING										
THE STREAM.										
DID NOT WALK ROAD BUT WAS OBSERVED										
FROM OPPOSITE SIDE OF WETLAND ON										
6100 SPUR LANDING										
Total										

STOSSEL CR

Form 3. Road Segments With Erosion Indicators

WAU TOLT **Seg Map Number** 6183-B **Segment Type** 26NBE S 30-31

Road Position TOE TO BENCH **Use** 6G **Indicator** ______

Surface Type RIVER GRAVEL **Surf. Depth** 6" **Road Age** 1/2 <3YR **Parent Material** REC. OUTWASH

0.9 MILES 2-19-93 MR

ROAD GRADIENT %	Cutslope-Veg %	Fillslope-Veg %	Ditch	Rutting or Gullying of Ditch?	Length	Width	Configuration	Direct Entry?	Stream Type	Comments
0-12%	50	80+	RECENTLY DITCHED	NO				N		LONG GRADIENT W/O
										CULVERTS - RILLING ROAD
										DITCHES CARRYING SEDIMENT
Total										

Form bb-3. Road Erosion Worksheet TOLT WATERSHED

Surveyed roads - Highlands

				CUTSLOPE			ECe +	FILLSLOPE			EFe +	DITCH			EDe +
(1) Road Segment/ Site	(2) Road Age yrs	(3) Rock Type	(4) Basic Erosion Rate-EB	(5) Value EC EB*0.40	(6) % Veg	(7) Veg Factor	(8) ECe	(9) Value EF EB*0.20	(10) % Veg	(11) Veg Factor	(12) EFe	(13) Value ED EB*0.05	(14) Armor Y/N	(15) Armor Factor	(16) EDe
6L Reservoir	>3	Andesite	40	16	50+	0.37	5.9	8	50	0.37	3.0	2	N	1	2.0

SURFACING			TRAFFIC (ETe x Use = ETec)			= ERe	DELIVERY		x ERd	= ER	
(17) Value ET EB*0.35	(18) Surface Factor	(19) ETe	(20) Road Use	(21) Use Factor	(22) ETec	(23) ERe	(24) Buffer Factor N = 0	(25) Direct Entry %/100	(26) ERd	(27) Overall ER Rate t/ac/yr	(28) Hazard Rating H/M/L
14	1	14.0	L	5	70.0	80.9	0	0.95	0.95	76.8	M

GAMING	
(29) ER Heavy Traffic	(30) ER Light Traffic
675	77
0	0
0	0

Wide road - 20' ; stream in ditch

Stream washout w/ direct outslope - adjacent to Res.

Rock fall requires frequent grading

Washout @ 2.8 miles - Delivery 90-100%

3/4 mile to S/Kerby Mtn - Spur Road 80% grade ; 750 feet unrelieved

Drive West

cut banks - mostly 100%

Ditches - almost all have water

Water over road

Cliff Section

Delivery

Debris Flows

~~||||~~ |

m bb-3. Road Erosion Worksheet TOLT WATERSHED

-surveyed road systems - Lowlands

				CUTSLOPE			ECe +	FILLSLOPE			EFe +	DITCH			EDe +
1) oad ment/ ite	(2) Road Age yrs	(3) Rock Type	(4) Basic Erosion Rate-EB	(5) Value EC EB*0.40	(6) % Veg	(7) Veg Factor	(8) ECe	(9) Value EF EB*0.20	(10) % Veg	(11) Veg Factor	(12) EFe	(13) Value ED EB*0.05	(14) Armor Y/N	(15) Armor Factor	(16) EDe
	2	Reces outwsh Till	70	28	0	0.5	14	14	0	0.5	7	3.5	N	1	3.5
				0			0	0			0	0			0
				0			0	0			0	0			0
				0			0	0			0	0			0

SURFACING			TRAFFIC (ETe x Use = ETec)			= ERe	DELIVERY		x ERd	= ER	
(17) Value ET EB*0.35	(18) Surface Factor	(19) ETe	(20) Road Use	(21) Use Factor	(22) ETcc	(23) ERc	(24) Buffer Factor N = 0	(25) Direct Entry %/100	(26) ERd	(27) Overall ER Rate t/ac/yr	(28) Hazard Rating H/M/L
24.5	0.2	4.9	G	1	4.9	29.4	0	0.05	0.05	1.47	L
0		0			0	0			0	0	
0		0			0	0			0	0	
0		0			0	0			0	0	

GAMING	
(29) ER Heavy Traffic	(30) ER Light Traffic
13.475	2.45
0	0
0	0
0	0

Form bb-3. Road Erosion Worksheet TOLT WATERSHED

Non-surveyed road systems - Highlands

				CUTSLOPE			ECe +	FILLSLOPE			EFe +	DITCH			EDe +
(1) Road Segment/ Site	(2) Road Age yrs	(3) Rock Type	(4) Basic Erosion Rate-EB	(5) Value EC EB*0.40	(6) % Veg	(7) Veg Factor	(8) ECe	(9) Value EF EB*0.20	(10) % Veg	(11) Veg Factor	(12) EFe	(13) Value ED EB*0.05	(14) Armor Y/N	(15) Armor Factor	(16) EDe
6G	>3	Andesite	40	16	30	0.53	8.48	8	30	0.53	4.24	2	N	1	2
Put-to-bed	>3	Andesite	40	16	20	0.63	10.08	8	0	1	8	2	N	1	2
6L	>3	Alluvium	50	20	50	0.37	7.4	10	80	0.18	1.8	2.5	N	1	2.5
Nonuse	>3	Andesite	40	16	30	0.53	8.5	8	20	0.63	5.0	2	N	1	2.0
Bobcat Titicaca	>3	Andesite/ Granite	40	16	0	1	16	8	0	1	8	2	N	1	2
	>3	Andesite	40	16	0	1	16	8	0	1	8	2	N	1	2
	>3	Andesite	40	16	20	0.63	10.08	8	0	1	8	2	N	1	2

SURFACING		(ETe x Use = ETec)	TRAFFIC			= ERe	DELIVERY		x ERd	= ER		GAMING	
(17) Value ET EB*0.35	(18) Surface Factor	(19) ETe	(20) Road Use	(21) Use Factor	(22) ETec	(23) ERe	(24) Buffer Factor N = 0	(25) Direct Entry %/100	(26) ERd	(27) Overall ER Rate t/ac/yr	(28) Hazard Rating H/M/L	(29) ER Heavy Traffic	(30) ER Light Traffic
14	0.6	8.4	G	1	8.4	23.12	0	0.33	0.3	7.6	L	143	19
14	1	14	---	0.01	0.14	20.22	0	0.1	0.1	2.0	L	72	9
17.5	0.2	3.5	L	5	17.5	29.2	0	0.33	0.3	9.6	L	62	10
14	0.6	8.4	N	0.1	0.8	16.4	0	0.33	0.3	5.4	L	144	19
14	1	14	G	1	14	40	0	0.5	0.5	20.0	L	363	48
14	1	14	N	0.1	1.4	27.4	0	0.5	0.5	13.7	L	363	48
14	1	14	P	0.01	0.14	20.22	0	0.1	0.1	2	L	72	9

TOLT RIVER WATERSHED ANALYSIS

SURFACE EROSION MODULE/ HILLSLOPES

by Nancy Sturhan, Soil Scientist
DNR Forest Practices Division

The surface erosion module, hillslopes section addresses such hillslope erosion processes as rilling and gullying. Sheetwash erosion is rarely seen in forests, but could occur in areas of contiguous compaction and exposure of mineral soil.

METHODS

Because the eastern half (higher elevation) of the Tolt basin was under snow during the analysis period, different methods of analysis were possible for the western lowlands vs. the eastern highlands. Assessment of hillslope surface erosion for the eastern highlands relied heavily on remote methods such as analysis of aerial photography, topographic maps, and the Soil Erosion Potential GIS layer. Field visits were possible in the lower basin to verify information gleaned from photo and map analysis.

Because of the necessity of relying on remote analysis in the eastern highlands, map units there are drawn perhaps a bit more extensive than might be possible under thoroughly field-checked conditions. A few extreme surface erosion situations, such as dragging logs across a stream, are visible on aerial photos, but reliance on information on <u>potential</u> surface erosion was used to extend map units into areas where extreme situations had not occurred or are not visible, but more subtle surface erosion might be occurring.

Visits were made to many of the harvest areas in the lower basin. Of the 31 sections that had timber harvested in them in the past five years, harvest sites in 13 sections were visited. In addition, field forms were completed for sites where surface erosion was observed on the ground or suspected from aerial photos. Eighty percent of these sites were found to be unable to deliver sediment to the streams, primarily due to the topography.

Past logging techniques were deduced from 1965 1:40,000 aerial photos. At that time large contiguous areas had been logged in the South Fork, the North Fork, and the lowlands. Logging extended to the creek. In some cases presence of a road on one side of the creek, with logging on both sides, may indicate yarding through the creek where full suspension was not likely. Current practices of leaving riparian zones for stream protection and yarding away from streams are all important improvements in logging techniques that can reduce the amount of surface erosion material reaching streams. Current logging practices in the Tolt basin have not covered as large contiguous areas as in the past. The table on page 7 shows that most recent logging has been on the lower erosion potential areas.

In general the amount of hillslope surface erosion that reaches the stream system is minor compared to the amount of fine material introduced from roads or debris events that introduce fines to the stream system. Hillslope sources of erosion tend to heal over time, where road surfaces will continue to provide fines to the system. Hillslope sources can be prevented or minimized by protecting the forest floor during harvest and site preparation. Protecting the forest floor near streams is the key to keeping hillslope erosion products out of the stream system.

SURFACE EROSION MAP UNITS
General Information

Surface erosion map units were developed that reflect the likelihood of surface erosion products being delivered to the stream system. The Surface Erosion Potential (SEP) GIS layer, which combines soil properties and slope as criteria for High-Medium-Low ratings, was developed a number of years ago as a comparative rating system that attempts to separate the obviously low and high potential surface erosion areas from average areas. The surface erosion potential polygons were developed using a combination of slope and soil texture as criteria. Soil texture affects the cohesiveness of soil as the finer clays help hold soil together, while sands do not hold themselves together well. For delivery and routing, coarse material tends not to travel as far as fine material. No deliverability of the erosion products was considered in the designation of the SEP rating system, and it should not be confused with the High-Moderate-Low Hazard ratings used in watershed analysis where deliverability is considered.

<u>The actual hazard areas should be considered as occurring on the ground between the stream channel and a distance of 50 feet horizontal distance for Moderate, and 75 feet horizontal distance for High, from the stream.</u> Horizontal distance is used so that the slope distance will be farther on steeper slopes. It is not

possible at the map scale used to accurately indicate the actual distance from the stream that should be considered to represent the hazard area. In the lowlands, the mapped locations were drawn thick enough to be able to display the appropriate hazard symbol. In the uplands the original surface erosion potential polygons are preserved, and the hazard area is that area within the mapped polygon that occurs within 50 feet horizontal distance of a Type 1-5 stream on Moderate Hazard or 75 feet on High.

PRESCRIPTION NOTES

Triggering Mechanism

All map units share some triggering mechanisms. Map units differ in the degree of susceptibility to the triggering mechanisms, and in the reasons for susceptibility. All map units are susceptible to soil disturbing activities that extend to the stream channel. Exposed mineral soil extending to the stream provides a direct route for surface erosion products to reach the stream. An example of this type of activity is where yarding scars extend to the stream channel.

The map unit that occurs in the upper river valleys on alpine glacial deposits is also susceptible to erosion by channelized flow that can result from such practices as installation of a culvert that is angled such as to direct flow against the banks of a channel, or blockage of a shallow drainage channel that overflows and cuts a new channel. Flow concentration can cause gullies to develop in this soil, as well. This map unit occurs on lower slopes that transmit a lot of water through the soil, and compaction or other soil disturbing activities are more likely to be delivered to the stream system where subsurface flows come to the surface.

The forest floor is the key in protecting soil from erosion. Where the forest floor remains intact, hillslope erosion does not occur. Where the forest floor is disturbed, erosion can occur. Where this disturbance leads to the stream, erosion products can be introduced to the stream system, the finer soil materials may travel far, coarser ones tend to deposit nearer the site where they originated.

Practices that help protect these surface erosion sites are those that preserve the herbaceous vegetation, shrubs, and forest floor intact near streams. Full suspension of logs is a practice that virtually eliminates disturbance of the forest floor during logging. One end suspension of logs and yarding away from streams can help minimize the introduction of surface erosion material to streams.

SURFACE EROSION MAP UNIT DESCRIPTIONS

There are five Surface Erosion Map Units identified for the Tolt watershed. The map units are separated into those of the lower basin in the western half of the watershed which is an area of low relief, and the upper basin in the eastern half of the watershed which is an area of steeper, more dissected terrain.

MAP UNIT	HAZARD RATING	GENERAL LOCATION
Lower Basin		
SE1	HIGH	steep terrace risers adjacent to streams
SE2	MODERATE	medium erosion potential next to streams
Upper Basin		
SE3	HIGH	steep slopes of upper watershed
SE4	MODERATE	medium erosion potential on steep slopes
SE5	HIGH	alpine glacial deposits in upper river, both forks, adjacent to streams

SURFACE EROSION MAP UNIT 1

Areas mapped SE1 occur on the steep terrace risers in the lower basin. Steep slopes on the glacial outwash deposits are susceptible to erosion from soil disturbance. Where these slopes occur adjacent to the stream system, they are mapped as SE1. Where the access to the stream system is interrupted by the lower terrace, erosion products are assumed to not be delivered to the stream system. Where streams are deeply incised into the glacial outwash deposit, sideslope tend to be especially unstable and susceptible to surface erosion.

Triggering mechanism: Disturbance of soil on the steep slopes adjacent to the stream system may cause soil material to deposit in the stream. Where continuous soil disturbance extends to the stream (ie yarding scars, road fill, gullies, etc.), delivery of erosion products is certain. Excessive soil disturbance on the hillslopes makes delivery to the stream system more likely because more material is dislodged and available for movement downslope. Where there is continuous vegetation cover, and/or the intact forest floor, adjacent to the stream, surface erosion products may not be delivered to the stream at SE1 sites.

SURFACE EROSION MAP UNIT 2

Areas mapped as SE2 occur on the soils less likely to erode than SE1, but where these soils occur adjacent to streams, there is a moderate hazard for delivery of soil material to the stream. This map unit occurs on the lower relief of the western half of the basin. SE2 mapped areas usually occurs on less steep terrace risers and other slopes where the streams tend to cut into the glacial deposits as they travel down the moderately steep pitches. Triggering mechanisms are the same as in SE1.

SURFACE EROSION MAP UNIT 3

Areas mapped as SE3 occur on steep slopes adjacent to the stream system in the upper basin. Many of these areas are also susceptible to shallow rapid mass wasting. The more highly dissected terrain has many occurrences of SE3 and SE4. Most streams in the upper watershed are partly or entirely in one of these map units. Triggering mechanisms are essentially the same as SE1.

SURFACE EROSION MAP UNIT 4

SE4 units are less susceptible to erosion than SE3 due to slightly gentler slopes or more cohesive soil structure. Triggering mechanisms are essentially the same as SE1.

SURFACE EROSION MAP UNIT 5

Areas indicated as SE5 occur in the upper river valleys of both the North and South Forks of the Tolt River. These deposits generally lie at low relief, but are easily eroded where they occur on steep slopes. Where streams cut through this material, the sideslopes may be steepened, and there is access to the stream system for erosion products

Triggering mechanisms in addition to those for SE1 include directing flow of water towards this soil by blocking or deflecting the flow of a channel.

CONFIDENCE

Confidence in the hillslope surface erosion map units for the western lowlands can be considered high. Characteristics of the topography played a strong role in limiting the deliverability of surface erosion products to streams in most cases. The sites where hillslope surface erosion products could reach a stream are delineated with high certainty. Geology interpretations, map and photo analysis, and field visits were in agreement, confirming the calls on hazard areas in the western lowlands.

Confidence in the hillslope surface erosion map units for the eastern highlands is somewhat lower than that for the lowlands. While geology, soil maps, and photo interpretation are in agreement to support the map units, field visits to the eastern highlands were limited. Because the actual map units are tied to proximity to the streams, the units likely capture the vulnerable areas. Field visits would locate areas where topographic or vegetative buffers may be acting to limit delivery. Also, field visits could locate areas where gullies not visible on photos actually extend some distance from the stream. Gullies that reach the stream system can be considered as part of the stream for delivery purposes, and can be protected from disturbance along the edges, limiting introduction of more surface erosion products into the stream system.

Certainty of the High vs Moderate calls is low between map units 3 and 4, relying on the SEP for that distinction. That difference may not be important to the prescription team, but if it is important, further field work would be required to distinguish the High from Moderate areas. If the team chooses to treat the Moderates as Highs, particularly in areas where the rule call is prevent or avoid, then further distinction would not be needed.

ADDITIONAL BACKGROUND MATERIAL

Soils have been classed by the soil survey as "fine", "medium", and "coarse" texture. A map has been provided showing the locations of these soils. To have significant amounts of clay, soils either develop from clay-rich parent material, or develop in place for a long period of time to produce clays. About 2% of the entire Tolt basin has the "fine" soils, none in the South Fork. Some of the coarse soils are described as having "pockets of volcanic ash" which would be a fine material, but apparently is not extensive. About 48% of the entire Tolt basin is in medium texture soils, and about 49% in coarse texture soils. The coarse soils and medium texture soils tend to be gravelly sandy loams(10-20%clay) or gravelly loamy sands(8-28%clay). The coarse soils tend to have >50 % rocks, while the medium texture soils in the Tolt tend to have 20-50% rock. The fine soils are silty clay loams. The fine soils in the Tolt developed from lakebed deposits, a clay rich parent material. The coarse and medium texture soils in the Tolt are too young to have developed much clay from their coarser parent materials. On the steeper slopes the soils remain perpetually young due to natural erosion processes.

TOLT - RECENT HARVEST

Area harvested in the past 5 years (1988-1992)

Harvest per surface erosion potential class

LOW	900 Ac.	54%
MEDIUM	625 Ac.	37%
HIGH	155 Ac.	9%

Area of the TOLT Basin per surface erosion class

LOWLAND	LOW	60%
	MEDIUM	35%
	HIGH	5%
HIGHLAND	LOW	20%
	MEDIUM	55%
	HIGH	25%
TOLT BASIN	LOW	40%
	MEDIUM	45%
	HIGH	15%

Most harvest in recent years has been on soils least vulnerable to surface erosion.